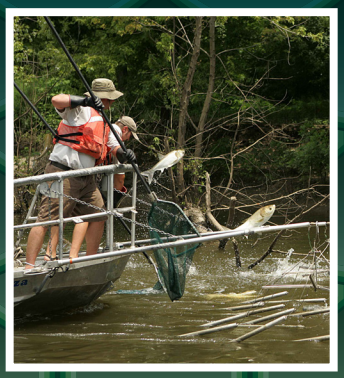
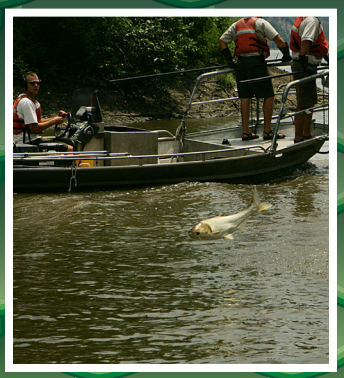
ASIAN CARP

Control Strategy Framework

June 2015





Asian Carp Control Strategy Framework

June 2015

Asian Carp Regional Coordinating Committee

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APPENDICES

EXECUTIVE SUMMARY

The Asian Carp Regional Coordinating Committee's (ACRCC's) Control Strategy Framework (Framework) communicates collaborative efforts among federal, state, provincial and other agencies to prevent the introduction of Bighead and Silver carp into the Great Lakes.

This 2015 Framework is different from past Frameworks in that it:

- Covers two Federal fiscal years, 2015-2016. Please note that this document is not a commitment to future funding and that all out-year actions are subject to the availability of future appropriations and allocation decisions.
- Includes a description of two additional species of Asian carp—Grass and Black Carp—that have not been included in previous Frameworks. Though Great Lakes Restoration Initiative (GLRI) funds are not used for Grass or Black Carp management efforts, this Framework includes mention of Black and Grass Carp threats and control efforts.

The Framework summarizes efforts in the Upper Mississippi River Basin and Ohio River Basin to provide additional context on the scope of Asian carp management. Though this 2015 Framework only includes actions to shield the Great Lakes from Asian carp, the ACRCC included mention of work on the Upper Mississippi River Basin and Ohio River Basin because the waterways are connected or adjacent to the Great Lakes and the ACRCC wanted readers to understand that ACRCC members are working in conjunction with prevention efforts on other waterways outside the Great Lakes to help inform and advance those efforts. Key initiatives in the 2015 Framework will focus on development and refinement of detection and control technologies, coordination and program support. In addition, the ACRCC will focus on the U.S. Army Corps of Engineers' Great Lakes and Mississippi River Interbasin Study (GLMRIS) alternatives to further advance control opportunities.

Additional executive highlights in this 2015 Framework include several new initiatives:

- As a continuation of the GLMRIS efforts, several multiagency coordinated Framework action items will seek to further delineate the feasibility of control technologies at the Brandon Road Lock and Dam area on the Upper Illinois River. One-third of Framework funding is directed at the Brandon Road effort.
- USGS, USACE, and the University of Illinois at Urbana-Champaign are collaborating on research to examine carbon dioxide (CO_2) effects on fish behavior in open-water evaluations. Efforts to initiate the registration process with the United States Environmental Protection Agency (USEPA) will also be undertaken collaboratively by USGS and USFWS.

- A third permanent electrical barrier is under construction in the CAWS upstream of the existing Barrier IIA and Barrier IIB with increased capability to stop fish passage. The construction will continue in 2015 with completion in 2017.
- The Eagle Marsh project, in Indiana, is being completed in 2015, will create an earthen berm across the floodway. It will be built in two phases to quickly maximize prevention of interbasin spread of Aquatic Invasive Species (AIS) while also preventing potential induced flood damages to properties currently in and adjacent to the floodplain between the basins.
- Illinois DNR is working to develop new management alternatives and control measures at Starved Rock Lock and Dam on the Upper Illinois River based on an extensive assessment of the Asian carp populations through the Illinois River.
- USGS and other partners are developing Integrated Pest Management Plans for strategic deployment of tools in the toolbox.
- Development of Risk Assessment Models to inform decision makers on the potential risk of invasion for species and locations.
- Canadian members of the ACRCC are developing response plans and working with U.S. partners on development of control technologies.

The 2015 Framework's strategy is to perform activities that will directly prevent Bighead and Silver Carp movement toward the Great Lakes. Each 2015 Framework action addresses specific management actions critical to controlling the movement of Asian carp. As in recent years, ACRCC initiatives will focus on development and refinement of detection and control technologies, coordination, and program support. In addition, the ACRCC will focus on the GLMRIS alternatives to further advance control opportunities. Several of these initiatives are highlighted below.

- USGS seeks to combine the tools, knowledge, and information needed to holistically detect, aggregate, remove, control, and exclude Asian carp, building on accomplishments and ongoing research efforts from 2014 and earlier.
- Illinois DNR will be continuing the harvesting of silver and bighead carp downstream of the electric barriers,
- As part of the integrated pest management (IPM) strategy, USGS will continue to test various attractants and work with them to effectively enhance control efforts and address other science needs.
- USGS continues to refine the use of microparticles as a toxicant delivery system specific for Asian carp. Field testing and registration efforts are under way.
- In 2015, sampling for small Asian carp will increase through netting and electrofishing operations. If small fish were found in the Upper Illinois Waterway, it would suggest an increased risk of Asian carp movement toward Lake Michigan.

A full listing of 2015 action items, project descriptions and intended outcomes is provided in Appendix B of the Framework.

The ACRCC is working at the highest level of collaboration and cooperation in its five-year history because of the dedication of its member agencies to coordinate efforts to prevent the introduction and establishment of Bighead and Silver Carp populations in the Great Lakes.

1.0 INTRODUCTION

Addressing the threat of Asian carp represents one of the greatest challenges to protecting the waters of the Great Lakes and adjacent aquatic ecosystems from aquatic invasive species (AIS). Throughout this document, Asian carp refers to the following four species: Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), Black Carp (*Mylopharyngodon piceus*), and Grass Carp (*Ctenopharyngodon idella*).

The 2015 Asian Carp Control Strategy Framework has been prepared by members of the Asian Carp Regional Coordinating Committee (ACRCC), including state, provincial, and United States and Canadian federal agencies and other stakeholders to develop and strategically implement targeted actions for preventing and controlling the movement of Asian carp. The primary focus is on preventing the introduction of Bighead and Silver Carp into the Great Lakes Basin. The actions described in this document are intended to address and control, to the greatest extent feasible, pathways that may introduce Asian carp into the Great Lakes Basin. Such actions will be strategically deployed using the most current scientific advances and technology available.

Black and Grass Carp are included for the first time in this 2015 Framework based on the increased need to control these species and prevent their further spread through the use of agency funding. Asian carp control efforts conducted by the ACRCC's Canadian federal and provincial partners are also included in this Framework to highlight the commitment to basin-wide collaboration, with the goal of furthering the mission of Asian carp control and Great Lakes protection.

1.1 PURPOSE

This Framework identifies the objectives and organizational structure of the ACRCC, including its work groups. It focuses on efforts taken within the Chicago Area Waterway System (CAWS) but also captures efforts outside the CAWS that indirectly assist the efforts of the ACRCC. The Framework specifically addresses the threat of Bighead and Silver Carp; however, the ACRCC members have chosen to also address the threat of Grass and Black Carp. This approach may change in future years as the binational ecological risk assessments for Grass and Black Carp are completed.

In addition, the Framework provides a direct link to the recommendations of the National Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States[1]. The Framework also serves to inform, though does not include, Asian

[1] Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carp in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C. 223 pp. http://www.anstaskforce.gov/Documents/Carps_Management_Plan.pdf.

carp prevention strategies being developed for other basins, such as the Upper Mississippi and Ohio River Basins.

Through the Framework, the ACRCC coordinates planning and executing projects for its members to prevent the introduction and establishment of Asian carp populations in the Great Lakes. The ACRCC provides oversight and coordination of multijurisdictional short- and long-term prevention activities. The primary objectives of the ACRCC include efforts to:

- Promote collection of biological information on Asian carp, their impacts, and preferred habitats, to better understand the species and their biological and ecological requirements.
- Identify additional research, technology, and data needs to effectively inform and support Asian carp management strategies.
- Support the development of technologies and methods that will result in the control and management of Asian carp; and the transferability of these new tools for use in the control of other invasive species, where possible.
- Encourage the exchange of information between member agencies and stakeholders, and seek opportunities to transfer technologies developed as part of the Framework to other areas of the United States and Canada. Work under this objective by the ACRCC fulfills the coordination and notification requirements of the United States-Canada Great Lakes Water Quality Agreement.
- Develop the comprehensive framework (completed) and annually coordinate the development of potential projects for inclusion in the Framework.
- Coordinate implementation and evaluation of the effectiveness of collaborative Asian carp assessment, prevention and control measures, as described in this Framework.

The organizational structure of the ACRCC and its work groups is further described in Section 8.0.

1.2 Mission of the ACRCC

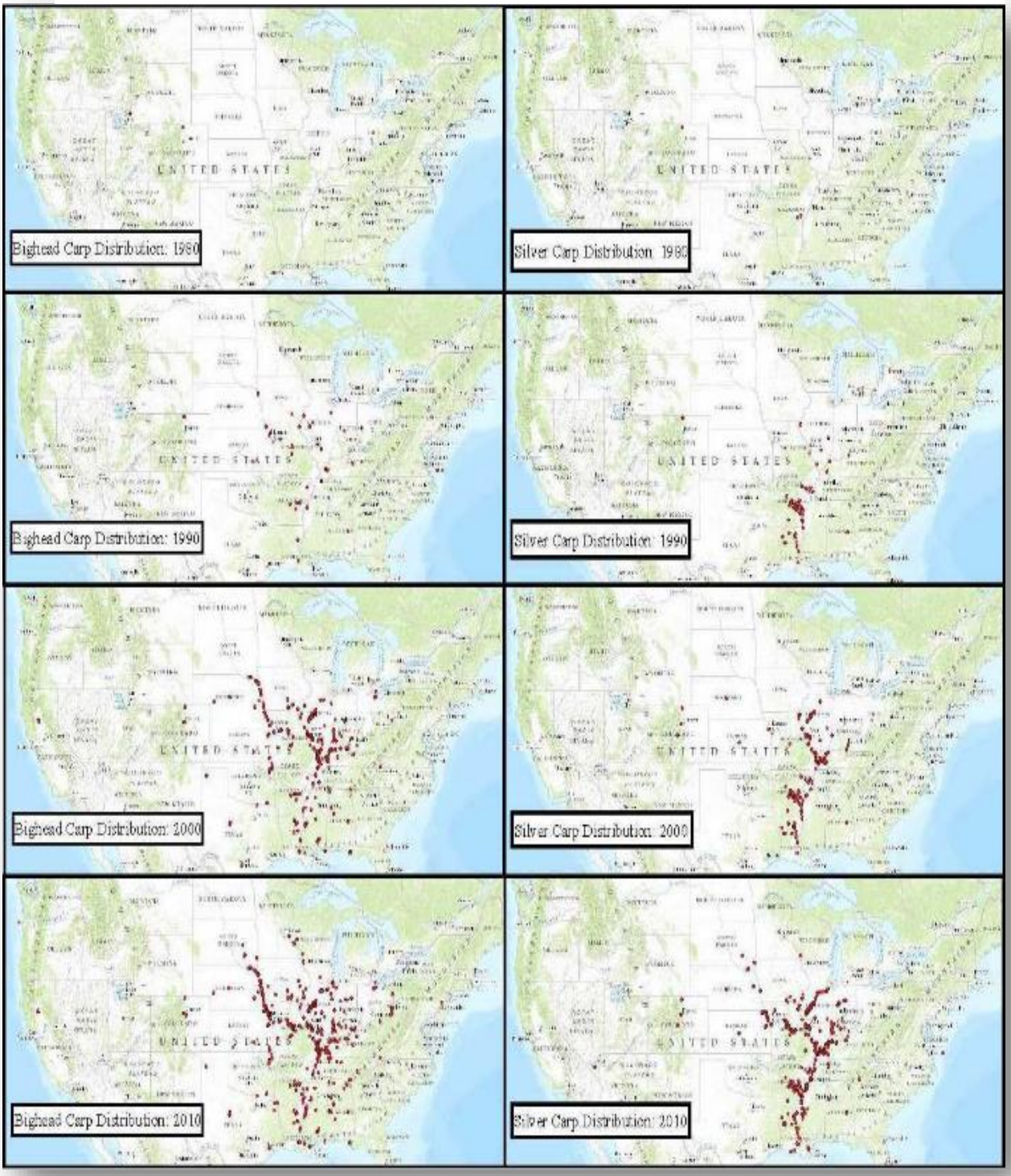
With support from United States and Canadian federal, state, provincial, and local agencies, and other private stakeholder entities, the ACRCC will continue to maintain a holistic Asian carp prevention and control program to protect the Great Lakes ecosystem from the introduction and establishment of Asian carp populations. This Framework describes the strategies and proposed action items to achieve that goal.

1.3 Situation

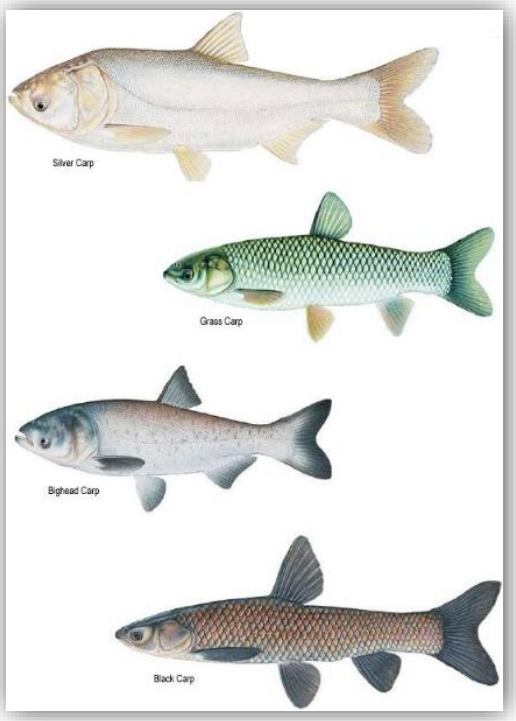
Recent data indicate that the geographic ranges of Bighead and Silver Carp are expanding in the Mississippi River and Ohio River Basins, threatening invasion into the Great Lakes and other waterways. Additionally, evidence shows the increasing

dispersal of Black Carp upstream in rivers of the Midwest Unites States, including the Mississippi and Illinois Rivers.

Figure 1. Bighead and Silver Carp Distribution Since 1980



The threats from introduced species to our native aquatic ecosystems have existed for many decades. Since the beginning of the 19th century, many non-native species have been introduced into the Great Lakes. Currently more than 180 of these non-native species are considered invasive, causing ecological or economic damage and threatening human health. These invasive fish, invertebrates, viruses, bacteria, and parasites can devastate native communities and cause great economic damage to the Great Lakes' commercial, sport, and tribal fisheries. The potential invasion of Bighead and Silver Carp is one of the most serious invasive species threats facing the Great Lakes today. Figure 1 shows the increase of Silver and Bighead Carp in distribution throughout the United States since 1980.



The ecological and economic damage experienced in the Mississippi River Basin after the Bighead and Silver Carp invasion is a forewarning of potential impacts from these species to other watersheds, including the Great Lakes. The continued increases in population size and upstream range observed in the Mississippi River watershed for both Bighead and Silver Carp ultimately inspired extensive mobilization of local, state, and federal agencies and the creation of the ACRCC as a unified interagency team responsible for coordinating and conducting prevention and control activities for the protection of the Great Lakes. Though not as widely distributed as the Silver and Bighead species, Black Carp remain a threat based on their diet, their potential ability to outcompete native species for food, and longer life span. This may increase opportunities to cause more damage within invaded areas.

Establishment of Bighead, Silver, or Black Carp populations in the Great Lakes could have long-lasting negative effects on communities and other stakeholders. Impacts would may be multifaceted, potentially affecting the ecology, biology, and economic and social function of the Great Lakes region. Each potential impact is interrelated with the others, with complex relationships, necessitating development of an active, multi-disciplinary approach to understanding, addressing, and preventing the introduction of these species into the Great Lakes.

1.3.1 The Asian Carp Threat in the Upper Midwest United States

Threats to the Great Lakes Basin can be inferred from the increased range and distribution of Asian carp within the Mississippi and Ohio River Basins. Records of occurrences are found in the U.S. Geological Survey (USGS) Nonindigenous Aquatic

Species (NAS) database (http://nas.er.usgs.gov/). These records are informed by resource management agencies and public contributions. The following sections discuss the threat to the Great Lakes from each of the four species of Asian carp identified within the Framework.

As presented in the U.S. Fish and Wildlife Service (USFWS) Asian Carp 2014 Report to Congress[2] and summarized in the following sections, data demonstrates that each of the four species of Asian carp has increased its range in the UMRB within the last 2 years. Additionally, Grass Carp and Silver Carp have increased their ranges in the ORB. Silver Carp show the greatest spread over the past 2 years within the UMRB and ORB drainages, with more than 100 miles of movement upstream in the UMRB and 50 miles in the ORB. In the upper Mississippi River, Bighead, Silver, and Grass Carp have moved farther into Minnesota, and occurrences of Black Carp continue in the lower Illinois River approximately 305 miles from Lake Michigan.

Silver Carp

From 2012 to 2014, Silver Carp expanded their range upriver in the Upper Mississippi River Basin (UMRB) approximately 118 miles upstream into the State of Minnesota (Figure 2). In the Ohio River Basin (ORB), detections indicated they moved approximately 56 miles upriver in waters shared by the States of Ohio and Kentucky. The reporting of 33 Silver Carp in the UMRB since 2012 indicates the bypass of seven navigational dams on the Mississippi River (Lock and Dams 2, 3, 4, 5, 5a, 6, and 7). Since 2012, there were 42 captures reported in the NAS database in the ORB, but no additional lock and dam structures were bypassed.

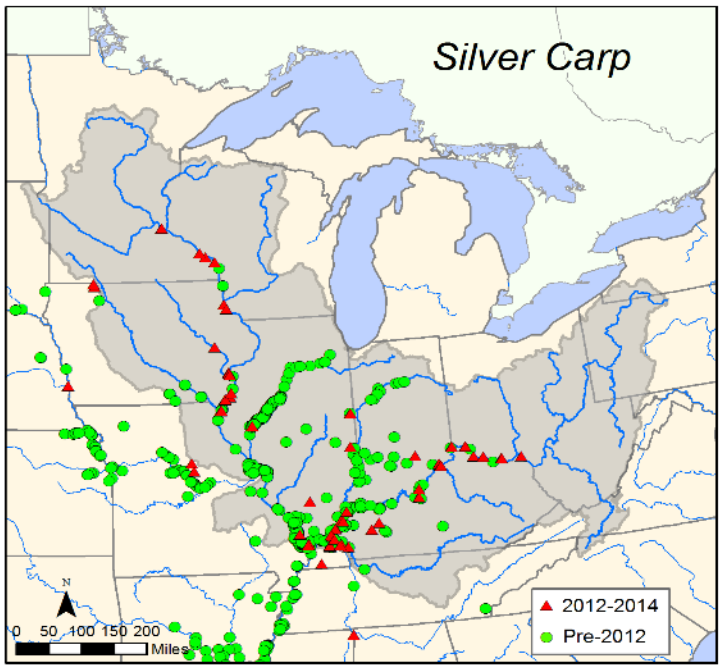


Figure 2. Range expansion of Silver Carp in the UMRB and ORB Basins shaded grey. Green circles represent occurrences before 2012. Red triangles indicate occurrences from 2012 through 2014.

Although estimates of population size are not available, Silver Carp appear to be the most abundant species of Asian carp in the UMRB and ORB. Population estimates are available for the lower Illinois River, a tributary to the Mississippi River and the connecting water body from the UMRB to the Great Lakes. It has been estimated that the three lower reaches of the Illinois River (the

[2] Report to Congress, Summary of Activities and Expenditures to Manage the Threat of Asian Carp in the Upper Mississippi and Ohio River Basins, June 2012 to June 2014, USFWS, January 2015. http://www.fws.gov/midwest/fisheries/asian-carp/WRRDA2014.pdf

first 231 miles of the Illinois Waterway (IWW), up to Starved Rock Lock and Dam about 100 miles from Lake Michigan) contained approximately 3.1 million pounds of Asian carp, of which Silver Carp make up about 90 percent of the population density of which Bighead Carp make up 70 percent of the biomass[3].

Bighead Carp

From 2012 to 2014, the range of Bighead Carp expanded upstream in the upper Mississippi River to a location within Minnesota waters, bypassing Lock and Dam 2. Upstream range expansion of Bighead Carp was not detected in the Ohio River (Figure 3). A total of 27 Bighead Carp in the UMRB and nine in the ORB were documented between 2012 and 2014. Population estimates of this wide-ranging species are not currently available for these locations. However, Bighead Carp is likely the second most abundant species of Asian Carp in the UMRB and ORB.

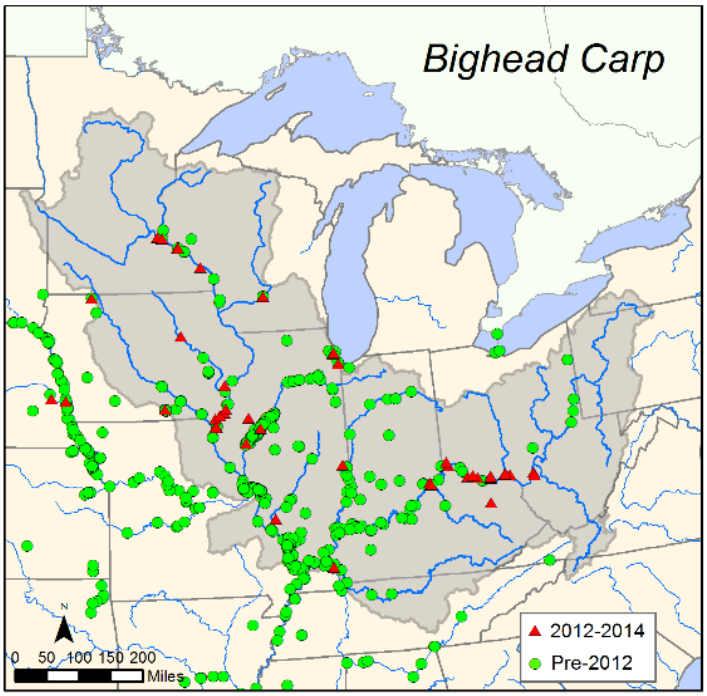


Figure 3. Range expansion of Bighead Carp in the UMRB and ORB. Green circles represent occurrences before 2012. Red triangles indicate occurrences from 2012 through 2014.

Bighead and Silver Carp Population Front

Based on the proximity of large established populations of Bighead and Silver Carp in the middle and lower (downstream) segments of the Illinois River, intensive ongoing monitoring has been focused on the upper IWW and the CAWS to improve the understanding of the population dynamics and level of risk from fish moving upstream toward the Great Lakes.

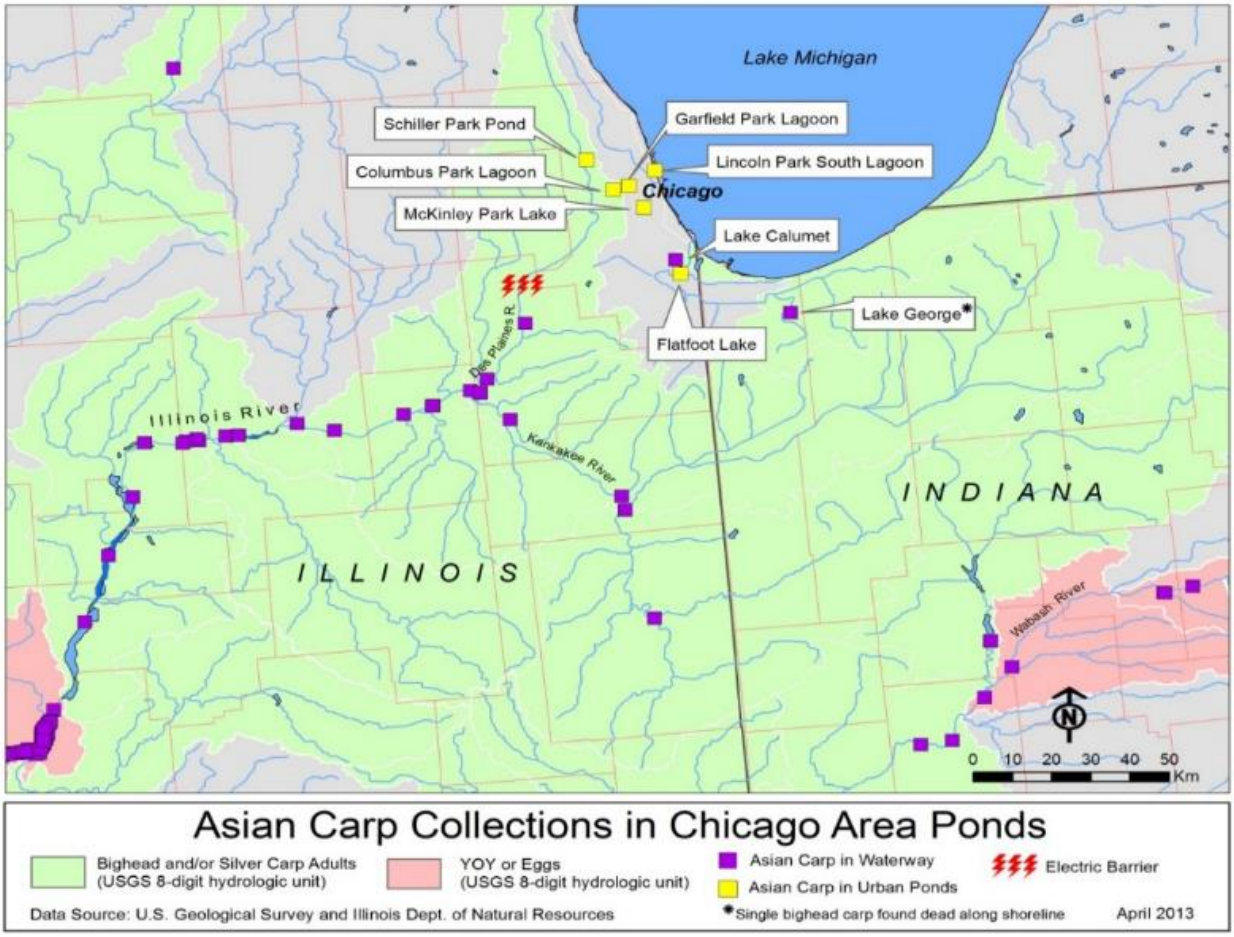
Figure 4 illustrates Chicago-area locations for individual captures of Bighead and Silver Carp.

In 2014, the ACRCC's Monitoring and Response Work Group (MRWG) concluded that the adult population front of Bighead and Silver Carp is approximately 55 miles and two lock structures from Lake Michigan. The presence of adult and potential spawning locations of Bighead and Silver Carp has been determined to be approximately 62 miles from Lake Michigan and includes the Starved Rock and Marseilles pools.

[3] Garvey, J.E, G.G. Sass, J. Trushenski, D. Glover, P.M. Charlebois, J. Levengood, B. Roth, G. Whitledge, B.C. Small, S.J. Tripp, and S. Secchi. 2012. Fishing Down the Bighead and Silver Carps: Reducing the Risk of Invasion to the Great Lakes. Report to the Asian Carp Regional Coordinating Committee. http://asiancarp.us/documents/interim/fa2/

Furthermore, verified spawning activity was identified at approximately 64 miles from Lake Michigan; however, concerted efforts have failed to document either eggs or larvae within the upper Illinois River. Prior to 2014, juvenile (less than 6 inches) or young-of-the-year Bighead or Silver Carp were never collected upstream of Henry, Illinois (River Mile 190), 143 miles from Lake Michigan. However in 2015 there were documented captures of juvenile Silver Carp. In April 2015, several juvenile Silver Carp were collected from Spring Valley, Illinois (River Mile 211). Though the overall leading edge of Asian carp invasion, currently at the Dresden Island pool, has not changed since 2006. It should also be noted that the Illinois Department of Natural Resources (Illinois DNR) has found Asian carp in isolated (geographically and incidental) urban ponds in the Chicago area[4]. These efforts are represented in Figure 5 on Page 8.

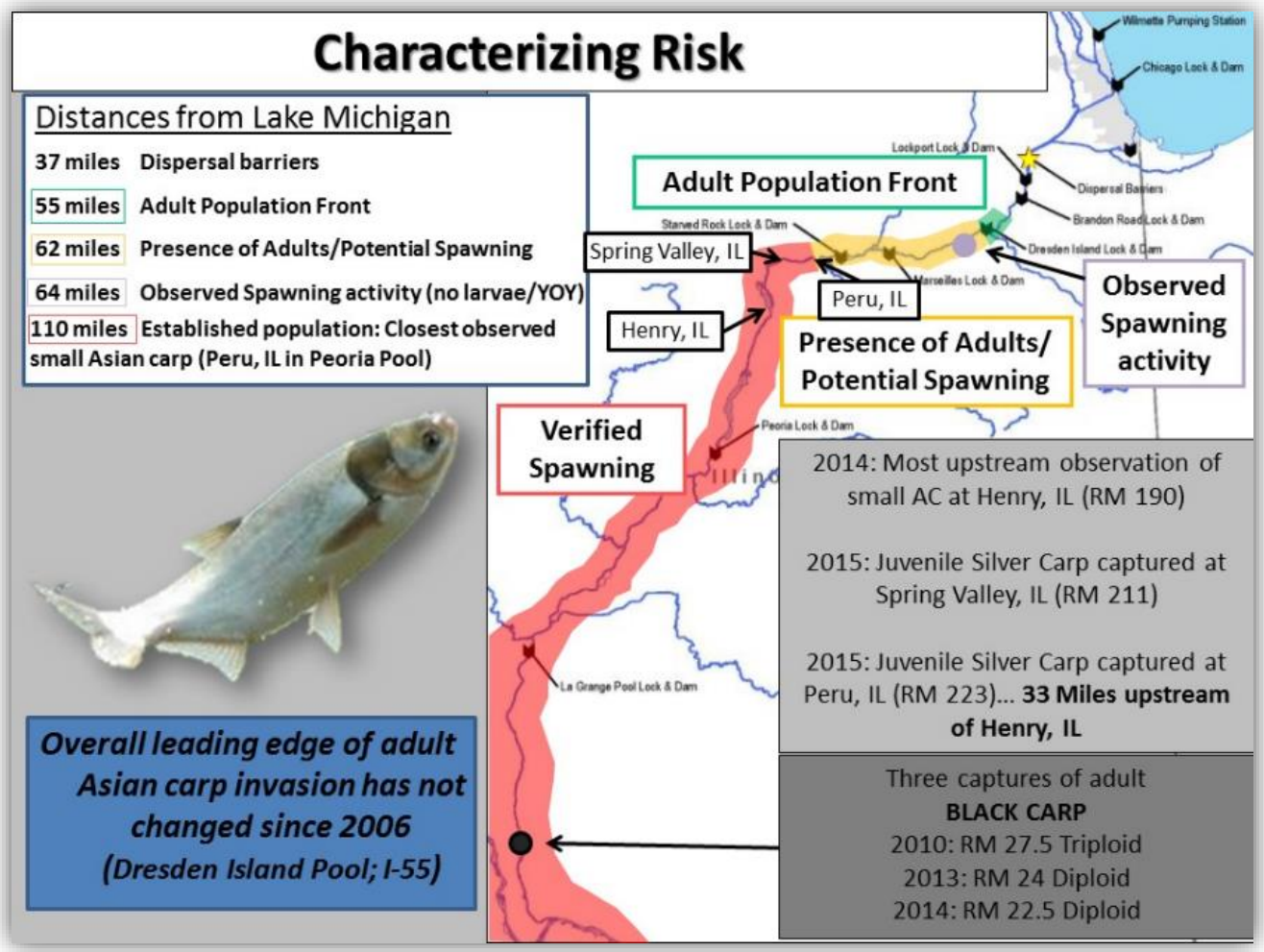
Figure 4. Bighead and Silver Carp Captures in the CAWS to Date



The green shaded areas indicate the presence of at least one individual adult fish in each delineated watershed. The areas in red indicate young-of-year (YOY) capture locations or where eggs have been collected, indicating the occurrence of natural reproduction. Fish captured in isolated ponds (those without hydrologic access to CAWS or the IWW) are depicted by the yellow boxes.

[4] Asian Carp Distribution in North America, K. Baerwaldt, A. Benson, K. Irons. White Paper, updated April 2014

Figure 5. Characterizing Risk of Asian Carp



Grass Carp

Historically, Grass Carp have been intentionally used by resource managers as a means of combating nuisance aquatic vegetation in ponds and lakes in the United States. Records indicate that by the mid-1970s, this species had been stocked in at least 45 states. Although not considered established outside of the Mississippi River Valley (except in Texas), Grass Carp are now the most widespread species of Asian carp in North America (currently documented in 45 states and Puerto Rico).

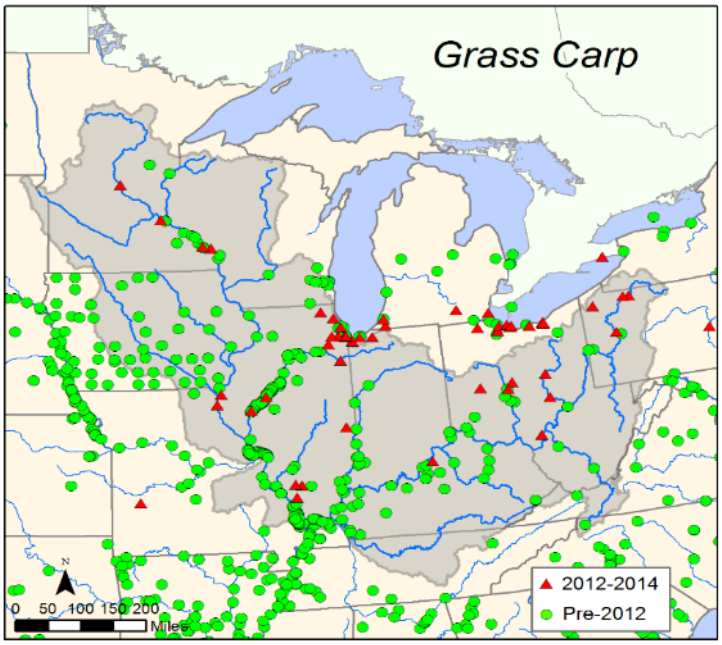


Figure 6. Range expansion of Grass Carp in the UMRB and ORB. Green circles represent occurrences before 2012. Red triangles indicate occurrences from 2012 through 2014.

From 2012 to 2014, Grass Carp expanded their range northward (upriver) in the Upper Mississippi River by approximately 109 miles into Minnesota waters (Figure 6), bypassing three navigational locks (Lock and Dam 1, St. Anthony Falls Lower Lock and Dam, and St. Anthony Falls Upper Lock and Dam); and one hydroelectric dam (Sartell Dam, just north of St. Cloud, Minnesota). The upstream expansion of the Grass Carp range in the ORB was demonstrated by the capture of two triploid fish in the Allegheny River, a tributary of the Ohio River in Pennsylvania. A total of 16 Grass Carp were reported in the UMRB since 2012; 11 individuals were captured in the ORB during that time. See section 7.0 below for potential Grass Carp implications in the Great Lakes. Please see USFWS Asian Carp 2014 Report to Congress, for a discussion on Grass Carp ploidy[5]. Ploidy refers to the number of chromosome sets within an organism and affects reproducibility.

Black Carp

Black Carp represent the fourth species of Asian carp imported into the United States in the early 1970s, likely in conjunction with the importation of one or more other Asian carp species. Black Carp grow to relatively large sizes and are longer lived than other species of Asian carp. As a molluscivore (feeds on mollusks and snails), its preference is to occupy benthic areas of rivers, making it ideally suited for use as a biological control agent of snail populations in aquaculture ponds. Because of its known feeding ecology, its escape into the Mississippi River raised significant concern among resource

[5] Annual Report to Congress: Summary of Activities and Expenditures to Manage the Threat of Asian Carp in the Upper Mississippi River and Ohio River Basins, June 2012 to June 2014. U.S. Fish and Wildlife Service. 2015. http://www.fws.gov/midwest/Fisheries/WRRDA.html.

managers for the long-term viability of the historical native mussel fauna in the UMRB, of which 70 percent are already imperiled or already extinct. Black Carp remains a preferred method of snail control in states with an established aquaculture industry, especially in the southern United States. Requirements governing their management, use, and intrastate transportation vary from state to state. Since 2007, they have been listed as an injurious species under the Lacey Act, prohibiting their interstate movement.

Given Black Carp's preference for benthic habitat, targeted monitoring must be employed to obtain accurate population data and risk assessment. Although captures of large adults in the IWW have alerted managers to the species' proximity to the Great Lakes Basin, reproduction and recruitment of Black Carp in United States. rivers have not been documented. Bones from Black Carp collected from the Mississippi, Kaskaskia, and Illinois rivers between 2011 and 2014 were chemically analyzed to determine their origin. Results from this analysis indicated that most Black Carp were the result of natural reproduction in the wild. Additionally, this data indicated that Black Carp reproduction is not confined to the middle and lower Mississippi River, but has also occurred in the upper Mississippi and Illinois Rivers[6]. These data are the first to suggest Black Carp are already naturally reproducing in these rivers. One Black Carp was a sterile triploid, which are used in aquaculture to ensure that escaped Black Carp cannot reproduce. As expected, chemical analysis of the bones of the triploid fish were consistent with an aquaculture origin.

In this same study, gonodosomatic index (GSI), age, and growth rate for each captured Black Carp specimen were evaluated. GSI is the calculation of gonad mass to total body mass, commonly used to assess sexual maturity. Of 19 fish tested, all but one was diploid.[7] Fish ranged in size from 17.5 inches to 54.3 inches (445 to 1,380 millimeters[mm]) in total length, and weighed between 2.4 and 76 pounds (1.1 and 34.5 kilograms [kg]). Age ranged from 2 to 16 years, with multiple year classes present.[8] A relatively strong year class appeared to be produced in 2011, perhaps the result of high-river discharge. The high numbers of fish produced is possibly correlated with the increased numbers of Black Carp caught by commercial fishers during 2013 and 2014, a time when fish grew to larger sizes and are prone to capture by nets and other gear.[9] All fish greater to or equal to age 6 were sexually mature. One age-4 female was also mature, generally earlier than reproductive ages previously reported for Black Carp in their native waters[10].

[6] Greg Whitledge, Fisheries and Illinois Aquaculture Center, Southern Illinois University, personal communication.
[7] Jen Bailey, USFWS, La Crosse Fish Health Center, personal communication.
[8] Duane Chapman, USGS, Columbia Environmental Science Center, personal communication.
[9] Ibid
[10] Nico, L. G., J. D. Williams, and H. L. Jelks. 2005. Black Carp: Biological Synopsis and Risk Assessment of an Introduced Fish. American Fisheries Society Special Publication 32, Bethesda, Maryland. 337 p.

From 2012 to 2014, Black Carp expanded their range into the Kaskaskia River within the UMRB of southern Illinois, approximately 70 miles from the nearest documented population in the Mississippi River (Figure 7). No expansion in range in the Upper Mississippi or Ohio Rivers has been documented. Individual occurrences of Black Carp in the UMRB after 2012 included a total of nine captures. No captures occurred in the ORB. Based on incidental catches, Black Carp appear to be the least abundant species of Asian carp in the UMRB and ORB. The number of fish reported in this region suggest either a low abundance of Black Carp or that current sampling strategies are not adequate to detect and enumerate Black Carp. To date, all captures within the UMRB and ORB have been made by commercial fishers as non-target by-catch. See section 7.0 below for potential Black Carp implications in the Great Lakes.

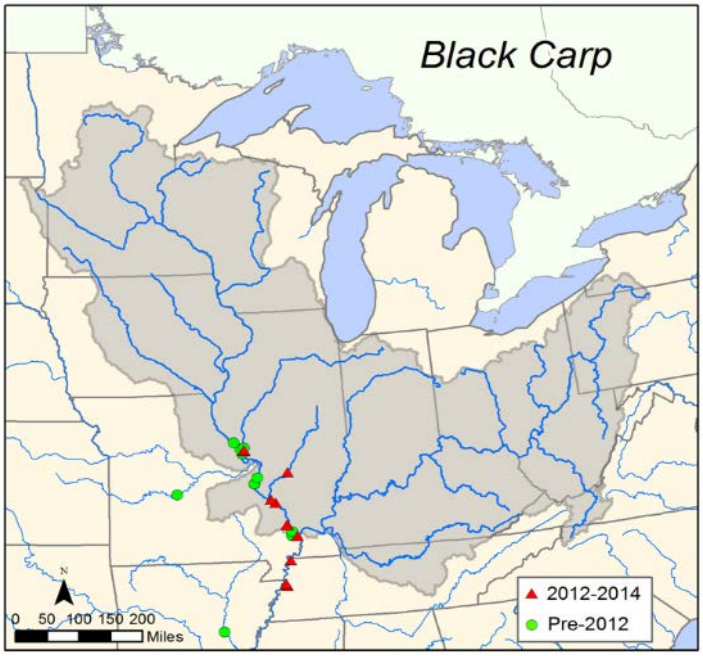


Figure 7. Range expansion of Black Carp in the UMRB and ORB. Green circles represent occurrences before 2012. Red triangles indicate occurrences from 2012 through 2014.

2.0 Asian Carp Risk Characterization and Assessments

Science-based predictive models and risk-assessments are critical for informing managers and scientists on locations at highest-risk for potential invasion, exploitation, or colonization by Asian carp. They also inform impacts to fish and wildlife, and their related benefits and users. These models consider species life history characteristics and incorporate biological, hydraulic, and other data to assess the probability of successful Asian carp invasion and reproduction in specified lakes and rivers. Additionally, economic and social impacts to local or regional economies can be derived, building on calculations of population-level impacts to specific natural resource assets. The following sections describe the various risk characterizations efforts and assessments that have been completed or are currently under way by the ACRCC member agencies. These efforts are evaluating the ecological risk of establishment of Asian carp in the Great Lakes and the social and financial risks associated with establishment. In addition, binational ecological risk assessments are currently being undertaken for Black and Grass Carp.

2.1 Potential Risk to the Great Lakes

Current conditions in certain locations within the Great Lakes and their tributaries and estuaries are suitable for Asian carp survival and reproduction. In portions of the lakes and their connecting corridors, water temperature, food abundance, habitat type, lack of natural predators, flow regimes, and access to wetland areas may provide conditions conducive to the establishment and propagation of populations of certain Asian carp species.

Ecological Risk

The Binational Ecological Risk Assessment of Bighead and Silver Carp for the Great Lakes Basin suggests that the major ecological consequence resulting from establishment and spread of Asian carp into the Great Lakes would likely be an overall decline in certain native fishes, including commercially and recreationally important species[11]. These declines may occur from direct competition with filter-feeding Asian carp for limited sources of plankton and other prey needed by forage (prey) fish or larval and juvenile life stages of other native species. This competition could lead to reduced growth rates and declines in the abundance of fish species, including impacts to commercially and recreationally valuable predatory sport fish.

[11] Cudmore, B., N.E. Mandrak, J. Dettmers, D.C. Chapman, and C.S. Kolar. Binational ecological risk assessment of Bigheaded carps (*Hypophthalmichthys* spp.) for the Great Lakes Basin. Fisheries and Oceans Canada. 2012.

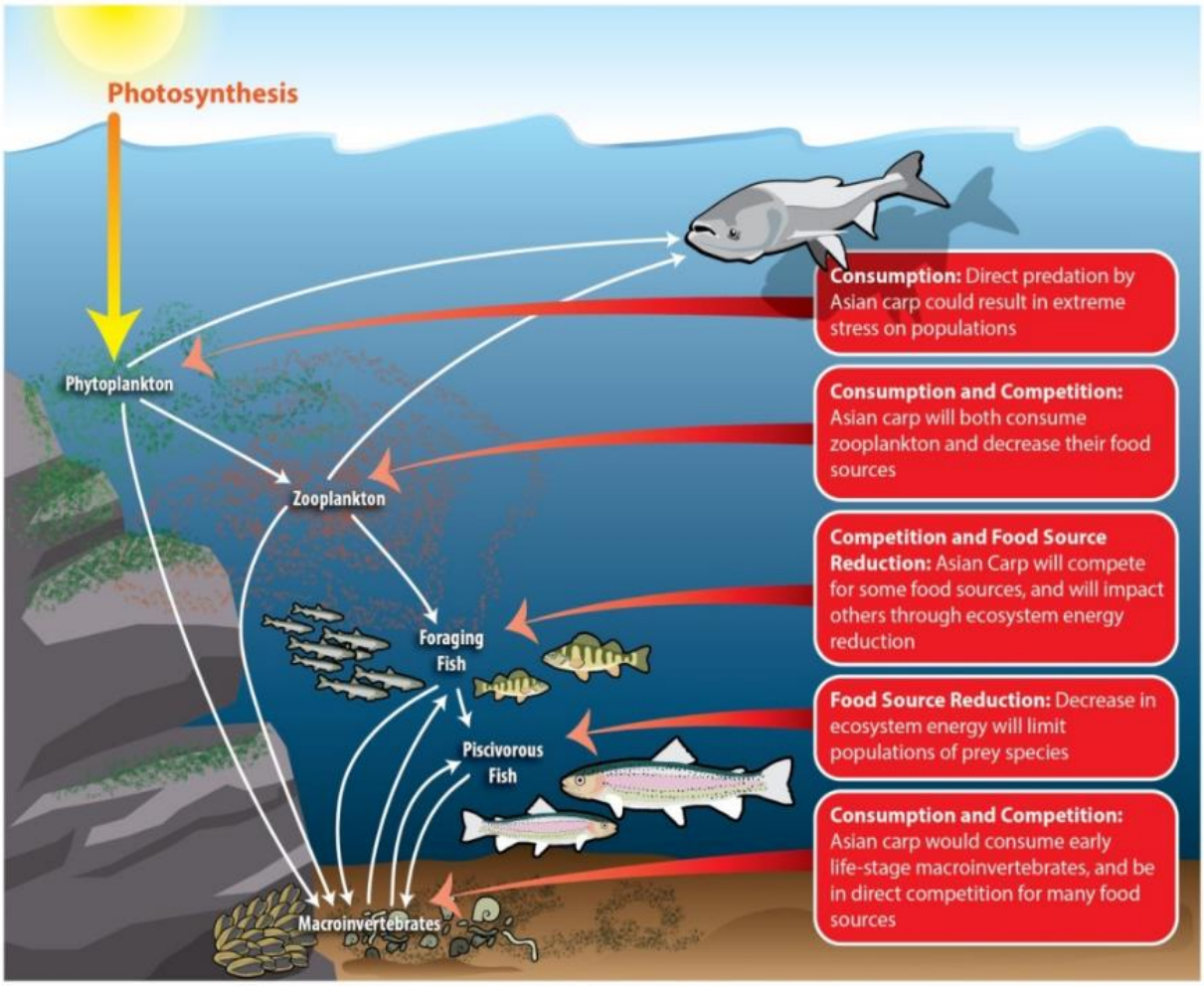
Portions of the Great Lakes and their associated tributaries represent viable habitat for Asian carp, as these fish can tolerate the climate of the region. Bighead Carp tolerate mean annual air temperatures between -2.2 degrees Celsius and 22.2 degrees Celsius (28 degrees Fahrenheit and 72 degrees Fahrenheit), and Silver Carp between -6.6 degrees Celsius and 23.8 degrees Celsius (21 degrees Fahrenheit and 75 degrees Fahrenheit). This climate range covers much of the United States and Canada, including the Great Lakes region[12]. The wetland areas surrounding the Great Lakes may provide habitat well suited to the growth and survival of larval and juvenile Bighead and Silver Carp due to the presence ample food sources and protection. Bighead and Silver Carp are primarily filter feeders, with specialized physiology particularly suited to removing extremely fine particles and organisms from water. Research has indicated that at least portions of the Great Lakes have algal foods sufficient to support Asian carp survival and growth[13]. Research further shows that Bighead and Silver Carp can support themselves on other food sources when plankton is not plentiful. This research indicates that they could spread throughout the Great Lakes, including areas with low amounts of plankton available for feeding.

Bighead and Silver Carp are equipped to greatly out-compete native species within the Great Lakes. These Asian carp are at a distinct advantage because they grow extremely quickly and reach large sizes. Silver Carp have been observed to grow to 12 pounds within their first year of life and reach weights of approximately 60 pounds. Bighead Carp can reach weights of approximately 110 pounds[14].

Figure 8 illustrates the current structure of the Great Lakes ecosystem and outlines the potential impacts of Bighead and Silver Carp introduction on various feeding guilds.

[12] Hansen, M. 2010. The Asian Carp Threat to the Great Lakes. Accessed September 18, 2011. On-line address: http://www.glfc.org/fishmgmt/Hansen_testimony_aisancarp.pdf. Great Lakes Fisheries Committee, Ann Arbor, Michigan.
[13] Anderson, K.R., D.C. Chapman, T.T. Wynne, K. Masagounder, and C.P. Paukert. In Press. Suitability of Lake Erie for Bigheaded carps based on bioenergetic models and remote sensing . Journal of Great Lakes Research.41:2
[14] U.S. Fish and Wildlife Service. "Asian Carp – Aquatic Invasive Species. Issues, Program Accomplishments, and Program Needs." On-line Address: http://www.fws.gov/midwest/fisheries/library/fact-asiancarp.pdf. Accessed on March 22, 2014.

Figure 8. Asian Carp Impact on the Great Lakes Ecosystem



Social and Financial Risk

The social implications of a Bighead and Silver Carp invasion within the Great Lakes range from indirect (outcompeting and thus impairing sport fish populations) to direct (physical harm to people). The risk to Great Lakes tourism and recreation from Bighead and Silver Carp may directly affect revenue based on those activities. Commercial and recreational fishing in the Great Lakes is an industry estimated to generate billions of dollars in revenue to the economies of both the United States and Canada[15]. An invasion of Bighead and Silver Carp to the Great Lakes would be detrimental to the fishing industry and related economies.

Existing AIS have an expansive impact on the economy of the Great Lakes region. A study commissioned by The Nature Conservancy analyzed the economic impact of AIS. The study estimated that AIS impacts could reach an annual cost of more than $100

[15] Barnhart, Gerald A. "The Threat Posed to the Great Lakes Basin by Asian Carp". House Subcommittee on Fisheries and Oceans. November 3, 2005.

million for their control and management[16]. This estimate considers only the current scope of AIS within the Great Lakes region. If Bighead and Silver Carp were to spread through the Great Lakes, costs induced could increase significantly.

Numerous industries have historically been affected by AIS, especially in the Great Lakes and Mississippi River watersheds. These same industries would most likely bear the burden of economic costs associated with the establishment of Bighead and Silver populations within the Great Lakes watershed. These entities include:

- Sport and Commercial Fishing: AIS change the composition and availability of species within an affected water body.
- Power Generation: AIS can impair the water intake infrastructure of power generation facilities, which is especially relevant with zebra and quagga mussels. Bighead and Silver Carp would likely not directly affect these facilities, but could contribute to resource impacts through ecosystem disruption.
- Shipping Industry: AIS may affect shipping businesses, primarily by making it necessary to institute alternative practices, routes, or shipping methodologies to avoid enabling movement or introduction of AIS into new areas.
- Tourism and Recreation: AIS primarily affect the tourism and recreation industries through ecosystem disruption. This disruption affects both the main attractions for tourism and recreation (fishing and boating) and public perception of the quality of the Great Lakes experience. Bighead and Silver Carp could have a significant impact, including lower-quality fisheries, potential danger from leaping Silver Carp.

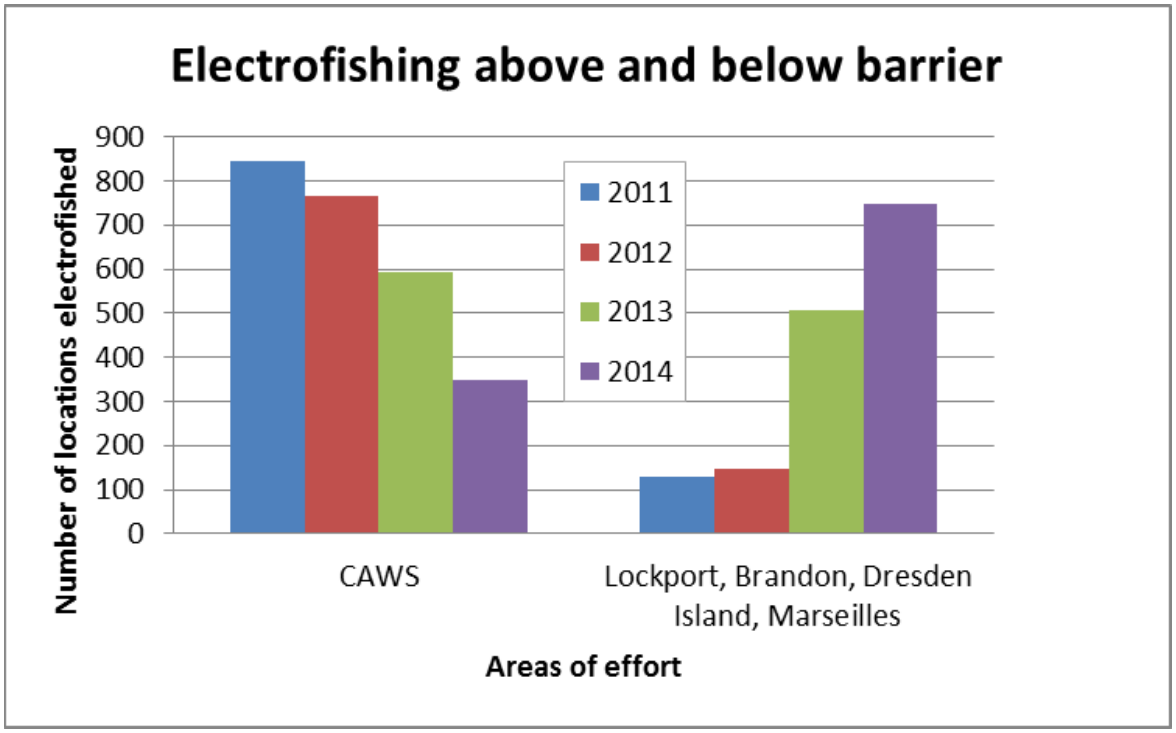
2.2 Risk Characterization of the CAWS

The Framework has guided efforts to protect the Great Lakes from Asian carp through formulating and implementing coordinated action in all areas necessary to detect, control, and respond to this threat, with a strong focus on the CAWS. Framework actions carried out in the CAWS and adjacent waterways are selected through an informed and integrated process, ultimately providing a more effective strategy for addressing the risk of Asian carp. As agencies and stakeholders gain new information from ongoing monitoring and assessment efforts, the ACRCC's Monitoring and Response Work Group (MRWG) has been able to focus additional efforts on emerging priority locations in addition to the CAWS. For example, well-established ongoing monitoring for the last several years has led to refinements with a higher degree of certainty with respect to the assessment of presence or absence of Asian carp, allowing for an adaptive management approach. Most recently, a reduction in efforts within the CAWS (above the barriers) has occurred, as consistent monitoring indicates there is a lower risk of Asian carp presence above and near the barriers. Concurrently, efforts below the

[16] Anderson Economic Group. 2012. "The Costs of Aquatic Invasive Species to Great Lakes States".

barriers were increased to help managers understand the dynamics of the population front several miles downstream, as demonstrated by electrofishing effort and gill and trammel netting efforts in Figure 9. The MRWG 2014 Monitoring and Response Plan characterizes the risk of Bighead and Silver Carp at the barrier as "little to low risk". The leading edge of adult Bighead and Silver Carp is approximately 12 miles downstream, through two locks and dams. This leading edge has not significantly changed since 2006 (Figure 5) when fish were first detected there, but it is important to note that data from telemetry and other monitoring methods have observed 29 Bighead Carp within the upper end of Dresden Island pool up to Brandon Road Lock and Dam since 2010. In addition to monitoring efforts, technological tools are increasingly important to assess fish populations either alone or in concert with standard fishery management tools. Hydroacoustic and dual frequency identification sonar (DIDSON) technologies, along with sonically tagged and trackable fish, are being used throughout the upper Illinois Waterway to aid managers in characterizing the risk and movement of Asian carp below the electric barrier. Additionally, in 2015, the use of environmental deoxyribonucleic acid (eDNA) monitoring as an ongoing early detection tool will be expanded above the barrier (in Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools). The use of eDNA will allow for the determination of baseline levels of genetic material corresponding to relative fish abundance and will also serve as a potential indicator of spawning times and locations, particularly in areas where successful reproduction of Asian carp has not yet been determined using conventional gear (such as nets, traps, and electro fishing equipment).

Figure 9. Electrofishing Efforts in the CAWS and Upper Illinois River



2.3 Binational Risk Assessment Efforts

In partnership with the Great Lakes Fishery Commission (GLFC), the Department of Fisheries and Oceans Canada (DFO) is co-leading binational ecological risk assessments for Grass Carp and Black Carp in the Great Lakes Basin. Both risk assessments will provide valuable advice for guiding prevention and control efforts on both sides of the border. The risk assessments will evaluate the probability of introduction (assessing the likelihood of arrival, survival, establishment, and spread) as well as the magnitude of the ecological consequences. Input into the assessments will include research and ecological modeling conducted in both Canada and the United States. Both risk assessments will undergo extensive peer review. The writing team for both assessments consists of DFO, GLFC, United States Geological Survey (USGS), and the United States Fish and Wildlife Service (USFWS).

Grass Carp

Development of the binational ecological risk assessment for Grass Carp in the Great Lakes Basin began June 2014. A mid-project progress meeting was held in December 2014. A draft of the risk assessment was completed in spring 2015, with the peer review currently in progress. In addition, a companion Grass Carp socio-economic impact assessment is currently under way.

Black Carp

The binational ecological risk assessment for Black Carp in the Great Lakes Basin began in December 2014. The draft risk assessment will be written in the fall of 2015, followed by peer review that winter. It is anticipated the ecological risk assessment will be finalized in the summer of 2016.

3.0 Asian Carp Program

The Asian Carp Program began in 2009 with efforts to strengthen the electric barrier system within the CAWS. The formation of the ACRCC brought together the agencies potentially affected by the expansion of Asian carp into new waterway systems. The scope of efforts as now expanded to other pathways for Asian carp, in addition to the CAWS to focus on additional pathways for Asian carp.

3.1 Background of the Asian Carp Control Strategy Framework

Development of this Asian Carp Control Strategy Framework began in 2009 when Bighead and Silver Carp were observed in the Chicago and Sanitary Shipping Canal (CSSC) roughly 43 miles from Lake Michigan and downstream of the U.S. Army Corps of Engineers (USACE) electric barrier system. The original Framework was developed in 2010 to establish the mission of the ACRCC and set forth a series of short-term and long-term actions to control the spread of Bighead and Silver Carp and prevent establishment of a Bighead and Silver Carp population within the Great Lakes. The goal was to create a systematic multi-tiered defensive approach against Asian carp beyond relying solely on the USACE electric barrier system. with Since that time, the ACRCC has released yearly iterations of the Framework to focus the strategy among each of the participating stakeholder agencies, increase agency collaboration, and communicate new or existing actions plans to further control species movement and establishment into new waterways of the Great Lakes Basin.

The 2013 Framework marked a programmatic shift toward long-term agency-funded efforts. New and sustained efforts in 2013 focused on the expansion of control and assessment strategies within the United States and Canada. Of note:

- DFO Canada and the Ontario Ministry of Natural Resources and Forestry (OMNRF) joined the ACRCC to increase binational Asian carp control efforts and improve collaboration among agencies.
- The transition of eDNA sample processing and analysis from USACE to USFWS began.
- Asian carp monitoring efforts were expanded into southern Lake Michigan, western Lake Erie, and other potential high-risk areas outside of the CAWS.

In 2014, the Framework again transitioned to a new strategy. The ACRCC targeted actions that had been successful in the past or had a high potential for success in the future for long-term control. The ACRCC reviewed lessons learned from the past 4 years of efforts and identified efficiencies and further areas for improvement. The strategy was based on this approach and focused on activities that directly prevent Asian carp dispersal toward the Great Lakes. New and continued initiatives in 2014 included the following:

- Expanded harvest of Silver and Bighead Carp downstream of the electric barriers;
- Initiation of the new Electric Barrier I construction;
- Targeted monitoring and assessment, including extensive use of eDNA as an early detection tool;
- Completion of the eDNA Calibration Study (ECALS) (discussed in Section 4.5);
- Development of new control technologies;
- Testing of new fish toxicants and attractants;
- Completion of the FluEgg model (discussed in Section 4.6) to assess the risk of successful Asian carp spawning in a river;
- Construction of a permanent berm at Eagle Marsh to decrease risk of AIS transfer at this pathway;
- Assessment of Killbuck Creek and Ohio-Erie Canal to decrease risk of AIS transfer, including Asian carp;
- Stricter enforcement of existing laws to reduce the risk of transfer of AIS; and
- Development of the Asian Carp Control toolkit, providing on-line basic information to resource managers and the development of control technologies, assessment technologies and communication efforts.

In 2014, the vigilant monitoring and assessment in the CAWS and the Upper Illinois River were maintained through the fixed and random sampling program called for in the CAWS Monitoring and Response Plan. In 2014, an intensive surveillance operation was conducted in Lake Calumet. Sampling efforts used electrofishing, seines, gill nets, experimental deep gill nets, hoop nets, and fyke nets over the course of 4 days. A total of 11,222 fish were collected; however, no Asian carp were present in the samples. A second intensive surveillance operation took place in the North Shore Channel and Chicago River. This event employed electrofishing, gill netting, and experimental deep gill netting harvesting techniques. A total of 11,367 fish were collected, but none of them were Asian carp. A consortium of agencies, including Indiana Department of Natural Resources (Indiana DNR), USACE, USFWS, U.S. Coast Guard (USCG), and Fisheries and Oceans (DFO) Canada, conducted both of these assessments.

In 2014, USACE completed and released the Great Lakes and Mississippi River Inter-Basin Study (GLMRIS) report. The GLMRIS report identifies eight conceptual alternatives – ranging from continuing current efforts to complete physical separation of the watersheds – for controlling the inter-basin spread of 13 aquatic nuisance species (ANS) of concern, including Asian carp, and evaluates the potential economic and environmental costs and benefits of each alternative. Note: ANS is a term used by USACE to describe aquatic invasive species that are also a nuisance species. These ANS of concern include fish, algae, virus, crustaceans, and plants in all life stages with high or medium risk of adverse impacts resulting from their transfer and establishment

through the CAWS. Based on the evaluations presented in the GLMRIS report and in response to stakeholder input, USACE has been directed by the Assistant Secretary of the Army (Civil Works) to proceed with a formal evaluation of potential control technologies to be applied in the vicinity of the Brandon Road Lock and Dam, located near Joliet, Illinois.

New to the Framework in 2014, the ACRCC supported the formation of a Brandon Road Work Group to focus effort on the Brandon Road Lock and Dam. This work group is considering the Brandon Road Lock and Dam and downstream approach channel as a potential location to halt the movement of Asian carp and other AIS through new or existing technologies. The work group improved interagency coordination to develop risk reduction measures in the vicinity of Brandon Road in the Upper Illinois River. In 2014, USGS coordinated with USACE to address research needs at Brandon Rd Lock and Dam by providing hydraulic data and analysis. In 2014, scientists completed intensive water velocity mapping in the lock and examined hydrodynamics in the Brandon Road Lock and Dam tail water. In addition, USGS also recently conducted tests in collaboration with USACE to determine watergun effects on lock approach channel structures.

The CAWS Advisory Committee provided recommendations to Congress on short-term measures for the Brandon Road Lock and Dam. This advisory committee represented 33 public and private stakeholders that benefit from and have responsibility related to the waterway, as well as regional stakeholder groups representing commercial, recreational, and environmental interests. Consensus was reached that Brandon Road Lock and Dam is an important site for the demonstration of one-way measures to reduce upstream movement of AIS into both the CAWS and the Des Plaines River. These measures include design of a new engineered channel to be constructed in the approach to the Brandon Road Lock, deployment of control technologies in the approach channel and the Brandon Road lock structure, and research into options for reconfiguring the lock to control AIS.

In 2014, the Illinois DNR formed an Invasive Species Unit during this time. This unit has gathered information throughout the State of Illinois on Asian carp producers, harvesters, and processors to facilitate tracking the movement of Asian carp and the interdiction of illegal shipments of invasive species. Illinois has taken a leadership role in enforcement and development of intelligence to facilitate operations within the Asian Carp Task Force to prevent illegal movement of Asian carp. One fish transportation company was fined more than $25,000 for selling aquatic life without an Illinois aquatic life dealer's license. The Illinois DNR Invasive Species Unit made the first arrest of a commercial fisherman who sold live Bighead and Silver Carp to an undercover agent in a covert operation. Additional efforts have been directed toward the bait industry in Illinois, and in 2014 the Invasive Species Unit arrested an Indiana bait dealer for selling bait and Grass Carp in Illinois without an aquatic life dealer's license, viral hemorrhagic septicemia (VHS) permits, or a restricted species permit. The owner pled guilty and paid a $4,000 fine.

3.1.1 FY 2015 Key Initiatives

Numerous key initiatives will be addressed through the 2015 Framework. As in recent years, ACRCC initiatives will focus on development and refinement of detection and control technologies, coordination, and program support. In addition, the ACRCC will focus on the GLMRIS alternatives to further advance control opportunities. Several of these initiatives are highlighted below. A full listing of 2015 action items, project descriptions, and intended outcomes is provided in Appendix B of this Framework.

Brandon Road Lock and Dam – As a continuation of the GLMRIS efforts, several multi-agency efforts will further delineate the feasibility of control technologies at the Brandon Road Lock and Dam.

Illinois River Stock Assessment/Management Alternatives – The Illinois Department of Natural Resource (Illinois DNR) is working to develop new management alternatives and control measures at Starved Rock Lock and Dam based on an extensive assessment of the Asian carp populations through the Illinois River.

Integrated Pest Management – Building on accomplishments and ongoing research efforts from 2014 and earlier, the USGS will lead this initiative to combine the tools, knowledge, and information needed to holistically detect, remove, control, and exclude Asian carp.

Waterguns – Since 2013, the USGS, in collaboration with partner agencies, has conducted research into the potential deterrent effects of waterguns on Asian carp. In 2015, additional research will be conducted to refine the technology and select locations for implementation of potential field trials on Asian carp.

Carbon Dioxide – The USGS, United States Army Corps of Engineers (USACE), and the University of Illinois at Urbana-Champaign are collaborating to examine carbon dioxide (CO_2) effects on fish behavior in open-water. Efforts to initiate the registration process for the use of CO_2 as piscicide for Asian carp control with the U.S. Environmental Protection Agency (USEPA) (including addressing Endangered Species Act Section 7 consultation, National Environmental Policy Act [NEPA], and all other regulatory requirements) will also be undertaken collaboratively by USGS and USFWS.

Chemical Attractants – As part of the integrated pest management (IPM) strategy, USGS will continue to test various attractants and work with them to enhance control efforts and address other science needs.

Microparticle Technology Development – USGS continues to refine the use of microparticles as a toxicant delivery system for Asian carp specifically. Field testing and registration efforts are under way.

Electrical Barriers – A third permanent electrical barrier is under construction in the CAWS upstream of the existing Barrier IIA and Barrier IIB with increased capability to stop fish passage. The construction will continue in 2015.

Young-of-Year and Juvenile Asian Carp Monitoring – In 2015, sampling for Young-of-Year (YOY) and juvenile Asian carp will increase through netting and electrofishing operations. If small fish are found in the Upper Illinois Waterway, it would suggest an increased risk of Asian carp movement toward Lake Michigan.

Eagle Marsh Separation Project – This site was identified by GLRMIS as a potential pathway for AIS, including Asian carp, to the Great Lakes. The Eagle Marsh project, under way in 2015, will create an earthen berm across the floodway. It will be built in two phases to quickly maximize prevention of interbasin spread of AIS while also preventing potential induced flood damages to properties currently in and adjacent to the floodplain between the basins.

eDNA Monitoring – USFWS, in cooperation other partners, will continue to monitor and refine the technology for the presence of Asian carp eDNA in the CAWS and the Great Lakes Basin using a statistically tenable sampling protocol.

National Asian Carp Control – USFWS is increasing its leadership activities and providing increased funding for efforts outside the Great Lakes Basin, as directed under the Water Resources Reform and Development Act of 2014 (WRRDA). The USFWS expects to fund projects for Asian carp management in both the Upper Mississippi River and Ohio River Basins in 2015, with the goal of preventing upstream spread.

Ohio River and Upper Mississippi River Strategy Development – State and federal agencies are continuing to work collaboratively in the Ohio River and Upper Mississippi River Basins to finalize and implement Asian carp prevention strategies, and incorporate state-of-the-art science, data, and lessons-learned.

Canadian Comprehensive Asian Carp Control Actions –Canadian partners are developing Asian carp control technologies and are undertaking monitoring and assessment efforts in the Canadian waters of the Great Lakes. In addition, they are working to improve science on control technologies and to assess the risk of Asian carp invasion, specifically Grass and Bighead Carp.

CAWS Advisory Committee – The CAWS Advisory Committee – a multi-stakeholder group empaneled to explore options to prevent the two-way movement of AIS in the CAWS – is also considering potential impacts to maritime transportation, flooding, and water quality. The advisory committee is also considering the extent to which a long-term solution can create local and regional benefits and how to structure local and regional cost-sharing.

Asian Carp Web Sites – The ACRCC web site, www.AsianCarp.us, will be expanding its content to include information and actions dealing with Asian carp across the United States, with a particular added emphasis on the UMRB and ORB. In addition, the Invasive Species Centre has developed a Canadian web site—- www.asianCarp.ca — that will focus on a Canadian perspective on the Asian carp issue and with largely Canadian content.

3.2 Expansion of Efforts Across the Great Lakes

The Great Lakes strategy presented in this Framework represents a multi-faceted, multi-agency approach. There are a number of key on-going efforts from a Great Lakes perspective. These efforts focus on:

- Implementing and operating an effective electrical barrier system,
- Continuing assessment of the Asian carp population below the barrier and identifying management alternatives,
- Developing an Integrated Pest Management (IPM) system to effectively control Asian carp,
- Identifying additional actions that may increase the effectiveness of existing controls, including Brandon Road Lock and Dam efforts,
- Physically separating the aquatic pathway at Eagle Marsh,
- Expanding monitoring and assessment efforts in the Great Lakes, and
- Addressing the Asian carp populations in the Ohio River and Upper Mississippi River Basins.

These efforts and more are described below, with more detail provided in Appendix B.

3.3 Other Pathways

GLMRIS is a study authorized in the Water Resources Development Act (WRDA) of 2007 that directs USACE to evaluate the range of options and technologies available to prevent spread of AIS between the Great Lakes and the Mississippi River Basins through the CSSC and other aquatic pathways. The study identified potential hydrologic connections between the two basins, explored existing and potential AIS of concern, and assessed AIS control technologies. The study was divided into two focus areas based on differences (in nature and complexity) between the hydrologic connection at the CAWS and the remainder of the interbasin divide. The team initially identified 36 potential pathways along the 1,500-mile-long basin divide. After review of available resource information, the team selected 18 of these pathways for more detailed evaluation. Of those, the three pathways discussed below are being addressed by the states and federal agencies. The full GLMRIS Report and pathway assessment reports for each pathway can be found on line at www.http://glmris.anl.gov.

3.3.1 Eagle Marsh Pathway

Eagle Marsh is a United States Department of Agriculture (USDA) – Natural Resources Conservation Service (NRCS) Wetland Reserve Program (WRP) wetland site near Fort Wayne, Indiana, owned jointly by Little Rivers Wetland Project and the Indiana DNR. The owners have been actively maintaining a temporary fence constructed in the marsh, as well as the Graham-McCulloch berm to prevent movement of Asian carp from the Wabash watershed into the Maumee watershed during flooding. Through ongoing efforts at Eagle Marsh, the USDA-NRCS has worked with the USACE and other federal, state, and local agencies to identify options for designing a berm to permanently restrict Asian carp from entering the Great Lakes via the Eagle Marsh. The NRCS holds a WRP easement on the site. To implement the closure, WRP funding will be used for

changes within the area of the easement, and Great Lakes Restoration Initiative (GLRI) funding will be expended to tie the berm in at the ends of the project, off the WRP property.

The Eagle Marsh project will create an earthen berm across the floodway to prevent mixing the watersheds at the 100-year flood level. It will be built in two phases to quickly maximize prevention of interbasin spread of AIS while also preventing potential induced flood damages to properties currently in and adjacent to the floodplain between the basins. The first phase will be completed by September 2015 and will consist of the entire berm, with the exception of a small notch (200 to 300 feet long) that will be built to the approximate 50-year flood elevation. A mesh screen will be installed along the length of the notch up to the top of the berm at both ends to prevent alteration of the flood crests, with a screen opening that will block AIS at elevations that exceed the 100-year, 1 percent chance flood event. The second phase will remove the screen and fill in the notch but cannot be completed until all flood risk in the area has been mitigated.

3.3.2 Little Killbuck Creek Pathway

The GLMRIS Aquatic Pathway Assessment Report developed by the USACE for the Little Killbuck Creek connection assessed the risk for transfer of AIS between the Mississippi River and the Great Lakes Basins. This connection was rated a medium risk for the transfer of Silver Carp, Bighead Carp, Black Carp, Inland Silverside, and Northern Snakehead and a low risk for the transfer of Skipjack Herring between the Mississippi River and the Great Lakes Basins. This connection was rated a medium risk for the transfer of Three Spine Stickleback, Ruffe, Tubenose Goby, parasitic copepod, and Viral Hemorrhagic Septicemia and a low risk for the transfer of European Fingernail Clam and European Stream Valvata for the movement of AIS between the Great Lakes and the Mississippi River Basins. The Ohio DNR has facilitated numerous meetings with the Medina Soil and Water Conservation District, USDA-NRCS, and the primary landowner. A consultant has been selected to conduct a preliminary investigation of closure options at the Little Killbuck Creek connection site. This study will be used to refine the closure options so that a final engineering study can be completed. The consultant will develop a preliminary assessment of the closure options by September 30, 2015. Ohio DNR will then meet with the primary landowner and other potentially affected parties to evaluate and identify the preferred alternative for closure. This alternative will be based on cost and potential impacts to local landowners.

3.3.3 Ohio-Erie Canal Pathway

The GLMRIS Aquatic Pathway Assessment Report developed for the Ohio-Erie Canal (OEC) connection calculated the risk for the transfer of AIS from the Mississippi River Basin to the Great Lakes Basin as a medium risk for transfer of Silver Carp, Bighead Carp, Black Carp, and Northern Snakehead and low for Skipjack Herring. Ohio DNR has met with the City of Akron to discuss the Aquatic Pathway Assessment Report. The Ohio DNR and the USACE discussed the two primary areas of concern:

- The direct transfer of water from the Mississippi River Basin to the Great Lakes Basin at the feeder gates that transfer water from Long Lake to the OEC.

- Flooding at the tow path that allows water to move from the Mississippi River Basin to the Great Lakes Basin

The Ohio DNR is working with the USACE to develop closure options and establish a path forward. The USACE completed a preliminary closure assessment in September 2014 with an array of potential options presented in the "Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures" (September 30, 2014). The array of options for closure was presented to the Ohio DNR in September 29, 2014.

Ohio DNR is currently working with USACE to complete the assessment of closure options with complete design plans and finalized cost. The USACE will be the lead agency for the assessment work, which will be completed in September 2015. Once the final engineering design is complete, the Ohio DNR will facilitate a meeting with the potentially affected parties to present alternative and preferred connection closure plans.

4.0 U.S. Strategy for Asian Carp Control

The 2015 Framework includes summaries of current and future collaborative efforts to assess and control Asian carp in support of Great Lakes protection. In 2015 and moving forward, the ACRCC is increasing its emphasis on evaluating past efforts to identify and, where appropriate, adapt and incorporate lessons learned to shape future strategy development.

4.1 Chicago Area Waterway System Strategy and Lessons Learned

Since 2010, the ACRCC's MRWG has developed, an annual Monitoring and Response Plan (MRP), a comprehensive, integrated, and adaptive management strategy to achieve the overall goal of preventing Asian carp from establishing self-sustaining populations in the CAWS and Lake Michigan.

The MRP was developed by the MRWG to achieve the following five strategic objectives:

1. Determination of the distribution and abundance of any Asian carp in the CAWS to inform response removal actions;
2. Removal of any Asian carp found in the CAWS to the maximum extent practicable;
3. Identification, assessment, and reaction to any vulnerability in the electric dispersal barrier to prevent Asian carp from moving into the CAWS;
4. Determination of the leading edge of major Asian carp populations in the Illinois River and the reproductive success of those populations; and
5. Improvement of our understanding of factors behind the likelihood that Asian carp could become established in the Great Lakes.

This plan is available on the ACRCC website at www.AsianCarp.us. Agencies throughout the Great Lakes Basin can use the MRP to guide their monitoring efforts, as desired.

Since late 2009, several rapid response operations have been conducted within the CAWS to halt the progress of Asian carp toward the Great Lakes. The MRP outlines a seasonal schedule for intensive sampling events at locations where Asian carp may appear in the CAWS, in addition to other sampling efforts.

Monitoring Efforts in the CAWS: Electrofishing, Netting, and Commercial Harvest

Comprehensives and intensive monitoring efforts are conducted within the CAWS to inform understanding of Bighead and Silver Carp movement near, and potentially within, the CAWS. These efforts are crucial for tracking the threat of invasion to the Great Lakes because the CAWS is the only permanent hydrologic link between the Mississippi River and the Great Lakes basins. As such, the monitoring and assessment efforts within the CAWS are designed to detect the presence of Bighead and Silver

Carp, as well as evaluate the significance of any potential invasions. These efforts are described in the following paragraphs.

From 2010 to 2013, Illinois DNR, USFWS, and USACE have collaborated to create a coordinated electrofishing plan within the CAWS. Five fixed sites are sampled regularly to monitor for the presence of Asian carp and to understand the composition of existing fish populations within the CAWS. Additional sites are randomly selected and sampled using electrofishing. The data collected during these sampling efforts, focused on monitoring for the presence of Asian carp, are being used to design a fishery-statistical model to quantify the potential of Asian carp presence or absence within the CAWS. Additional electrofishing has been conducted near the electrical barrier system to establish the presence or absence of Asian carp near the barrier system and to determine whether Asian carp are possibly passing through the barrier into the CAWS.

Monitoring efforts below the CAWS electric barrier system have been dedicated to assessing three primary factors: (1) the Asian carp population in areas where they are known to exist, (2) the leading edge of Asian carp invasion (including the leading edge of active reproduction), and (3) the stress applied to the electric barrier system by Asian carp. Efforts to monitor and assess the population of Asian carp and the location of the leading edge of invasion are primarily conducted through commercial harvest and dedicated netting efforts.

Sampling at the electric barrier system is used to estimate the population of Asian carp present near the electric barrier system by monitoring how often the electric barrier system is tested by Asian carp attempting to pass through.

The data indicates few or no Asian carp above the electrical barrier system, therefore the future electrofishing efforts will be focused below these barriers and decreased above the barrier system. . Seasonal events (spring and fall) will include electrofishing efforts throughout the CAWS above the barrier at the historical fixed sites, random sites, and in areas most likely to have Asian carp. The majority of the commercial fishing effort will be distributed below the electrical barrier system to inform on the leading edge and risk of Asian carp approaching the electric barrier system.

Additional monitoring and assessment within the CAWS has been conducted through contracted commercial fish harvesting and other netting efforts. Illinois DNR has a commercial harvest program in place both within the CAWS and in other areas with known Asian carp populations. By collecting information via contracted commercial fishers, this program aims to reduce the Asian carp population where present and to aid in monitoring for Asian carp in areas where they have not yet spread in significant numbers (such as the CAWS).

Within the CAWS, extensive monitoring data is acquired from the analysis of the harvest of commercial fishing vessels and dedicated netting efforts. Sampling efforts are conducted at multiple fixed sites and at random locations throughout the CAWS. In 2015, one 4-day planned intensive surveillance events will be conducted in accordance with the MRP for Asian carp in the Upper Illinois River and CAWS. This event

is designed to provide a thorough and detailed assessment of fish populations in locations of particular importance based on their connectivity to the CAWS or Lake Michigan and is intended to supplement past rapid response events.

With current information indicating few or no Asian carp above the electrical barrier system, the future contracted commercial fishing plan will intensify efforts below the barrier, specifically between Starved Rock Lock and Dam upriver to the electric barrier system, and decrease efforts above or lakeward of the barrier (as with electrofishing effort). In the fall of 2015, a sampling event will look throughout the CAWS above the barrier at the historical fixed sites, random sites, and areas most likely to have Asian carp. The majority of the commercial fishing efforts, as in past years, are distributed below the electrical barrier system to inform on the leading edge and risk of Asian carp approaching it. This balance of efforts above and below the electric barrier system will further allow intensive removal efforts to occur below the electrical barrier system.

Research is currently under way to develop more effective harvesting methods. DIDSON technology is being used to analyze net-avoidance behavior in Asian carp, and thus far, two different avoidance behaviors have been documented. These avoidance behaviors — as well as Asian carp reactions to different types of netting and harvesting techniques — will continue to be observed and documented and the information will be used to develop nets and harvesting with increased effectiveness for the Asian carp.

Monitoring efforts within the Des Plaines River are dedicated to understanding the extent of Asian carp invasion of the river (especially reproduction and spawning) and evaluating the possibility and likelihood that Asian carp would be introduced to the CSSC through Des Plaines River flooding. Monitoring and assessment efforts geared toward understanding Asian carp invasion and reproduction within the Des Plaines are primarily focused near Hoffman Dam, near Lyons, Illinois. Monitoring to determine the potential for Asian carp introduction to the CAWS directly from the Des Plaines River has been focused in areas where flooding occasionally provides a direct link between the Des Plaines and the CSSC. A 13-mile-long steel and concrete-reinforced fence has been constructed in this area to prevent Asian carp passage from the Des Plaines into the CSSC when the water bodies are hydrologically linked through flooding.

4.1.1 GLMRIS: Brandon Road Lock and Dam

Based on the evaluations presented in the GLMRIS report and in response to stakeholder input, USACE has been directed by the Assistant Secretary of the Army (Civil Works) to proceed with a formal evaluation of potential control technologies to be applied in the vicinity of the Brandon Road Lock and Dam, located near Joliet, Illinois. Independent analysis by USACE concluded that this direction is the most practicable next step in GLMRIS.

The Brandon Road analysis will evaluate the range of options or technologies available to prevent additional Mississippi River ANS transfer through the CAWS into the Great Lakes Basin. In GLMRIS, USACE has interpreted the term “prevent” to mean the

reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution.

The effort at Brandon Road will assess the viability of various options or technologies to control the one-way, upstream transfer of ANS through the approach channel or lock chamber and seek to minimize any adverse impacts to waterway users or resources created in implementing these ANS controls.

This effort will result in a feasibility-type document that will include sufficient planning, engineering, and design to support an agency decision toward authorization for construction of a water resources project. The completed document would also include required environmental compliance analyses and support justification of an agency decision.

As a component of the effort at Brandon Road Lock and Dam, USGS is coordinating with USACE to address research needs by providing hydraulic data and analyses. In addition, USACE and USGS will be collaborating on examining the use of carbon dioxide gas (CO_2) as a potential barrier to Asian carp in the lock approach channel downstream. Both agencies will work together to assess CO_2 effects on the lock structures. Water quality sampling and other needed data and analyses will continue into 2016 and as needed to provide USACE with the information to aid in making decisions at the Brandon Road Lock and Dam.

The Brandon Road Workgroup

Beginning in FY 2015 and considering potential actions in future years, the Brandon Road Workgroup will consider the following key concepts/actions and address them based on agency input and consensus:

- Further development of potential controls (CO_2 and water guns) while evaluating their use and implementation for the following:
    - Effects on civil structures,
    - Risk to general safety and human health concerns,
    - Environmental and water quality concerns, and
    - Potential impact on native fisheries and wildlife.
- Evaluation of a new or improved lock structure
    - The full description and "Flushing" approach is described in the GLMRIS report (www.glmris.anl.gov)
    - Further evaluation and modeling to determine effectiveness, feasibility, impacts, and cost.
- Determination of improvements to ensure no movement of Bighead and Silver Carp through the dam structure.
- Evaluation of potential impacts on barge traffic and lock operation.

- Assistance in evaluation of potential roles and resource needs in scoping, funding, and executing recommended investigations.

USGS Efforts at Brandon Road

USGS is coordinating with USACE to address research needs at Brandon Road Lock and Dam by providing hydraulic data and analyses. In 2014, scientists completed intensive water velocity mapping in the lock and examined hydrodynamics in Brandon Road Lock and tail water.

USGS water gun testing near Brandon Road Lock and Dam, Joliet, IL

In 2015, scientists will conduct further velocity mapping in the channel downstream of the lock. Also in 2015, a red dye will be applied to the water within and downstream of the lock to document mixing zones and rates within and downstream of the lock to help inform how to apply various control technologies in the future.

USGS recently conducted tests in collaboration with USACE to determine watergun effects on structures. In May 2014, waterguns were fired downstream from the Brandon Road Lock and Dam, and in early June waterguns were fired at Lemont, Illinois, in the Chicago Sanitary and Ship Canal (CSSC) to assess the pressure in the water and the velocity as it hits the channel walls. In both cases, the velocity imparted on the walls remained less than half of the USACE-allowed wall velocity. Additionally, the data suggest that the location, depth, orientation, and pressure of the watergun are key factors in how the pressure hits the walls.

USACE and USGS are collaborating on examining the use of CO_2 as a potential barrier to Asian carp. In 2015, both agencies will work together to evaluate the effects of CO_2 on lock structures. Water quality sampling and other data and analyses will continue into 2016 and as needed to provide USACE with the information to aid in making decisions at the Brandon Road Lock and Dam.

4.2 Great Lakes Basin Strategy

United States and Canadian agencies that manage Great Lakes fishery resources have a long-standing tradition of close collaboration on shared management issues within the basin, including addressing the treat of AIS. In support of collaborative multiagency efforts, the USFWS is implementing, refining, and adapting a comprehensive and complementary early detection and rapid assessment surveillance program for

Bighead, Silver, Grass, and Black Carp in and near the Great Lakes. This program is complementary to the eDNA sampling and monitoring programs currently being implemented by the USFWS, USACE, academia, and other partners. Under this program, sampling is primarily targeted on areas of high concern (highest risk of invasion or population establishment) in the Great Lakes (for example, southern Lake Michigan, western Lake Erie, and areas with past positive eDNA results). The best-available Asian carp detection tools, including a diverse array of traditional and novel gears to sample all Asian carp life stages, are employed in the program. Where possible, this sampling effort will be informed by species-specific risk assessments and other risk models for Asian carp as well as lessons-learned from existing AIS monitoring and early-detection efforts. The program is leveraging all appropriate methods and tools currently in use or being developed for the CAWS. Under this large-scale monitoring initiative, the USFWS works with its state and federal partners to refine and implement Great Lakes basinwide early detection protocols and standard operating procedures (SOPs) for Asian carp and other AIS. The initiative also coordinates with federal, state, and provincial partners to annually identify sampling locations (areas of concern), further develop and refine protocols, share information, and coordinate agency sampling efforts. The USFWS's monitoring efforts are conducted primarily through its network of Great Lakes Fish and Wildlife Conservation Offices, located in Ashland, Wisconsin (Lake Superior); Green Bay, Wisconsin (Lake Michigan); Alpena, Michigan (Lake Huron/Lake Erie); and Basom, New York (Lake Erie/Lake Ontario)

In 2013, the USFWS worked with partners to conduct coordinated and complementary sampling efforts in the Great Lakes Basin with both emerging technologies and traditional gears. From May to November 2013, 2,240 eDNA sampling along with electrofishing and set nets were used to assess the presence or absence of Asian carp. No Asian carp were captured in 2013; however, positive eDNA results were obtained during sampling conducted by the USFWS in three locations.

In 2014, the USFWS expanded its overall Great Lakes sampling efforts and collected more than 4,200 eDNA water samples, electrofished, fyke netted, trawled, sampled ichthyoplankton with a variety of gear, and set other nets (e.g., bongo nets) and traps (e.g., light traps, minnow traps, and windmere traps) to survey for adult, juvenile, and larval Asian carps and other aquatic invasive fishes. In Lake Superior, 87 electrofishing runs, 75 fyke net surveys, and 45 trawl surveys were completed across four sampling locations, and no new non-native species were detected. In Lake Michigan, 90 electrofishing runs, 55 fyke net surveys, 29 gill net surveys, 52 minnow trap sets, eight trawl surveys, five windmere trap sets, 119 bongo net tows, and 145 light trap sets were completed across five sampling locations, and no new non-native species were confirmed. In Lake Huron and western Lake Erie, 86 bongo net tows, 31 light trap sets, 60 fyke net surveys, 43 electrofishing runs, 45 trawl surveys, and 15 minnow trap sets were completed across four sampling locations, and no new non-native species were observed. In eastern Lake Erie, 36 larval fish and 67 juvenile and adult fish surveys were completed across two sampling locations. In Lake Ontario, 47 larval fish and 76 juvenile/adult fish surveys were completed across two sampling locations, and no new

non-native species were observed. No Asian carp were captured in 2014; however, positive eDNA results were obtained from sampling conducted by the USFWS in two locations outside the CAWS (Kalamazoo River and the Fox River and Lake Michigan).

4.2.1 2015 Lake-wide Control Strategy

Moving forward in 2015, the USFWS and its partners will continue to implement the standardized sampling protocols in the highest-risk locations in the Great Lakes, while continuing to refine and adapt the sampling plans and Standard Operating Procedures (SOPs) informed by the most current data and emerging technologies, ultimately to achieve an effective basinwide surveillance program. USFWS staff will be prepared and, if needed, mobilized to respond to any Asian carp detected (using either traditional gear or eDNA) in the Great Lakes. The USFWS and its partner agencies will fully implement a comprehensive Great Lakes basinwide early detection and monitoring program for Asian carp and other AIS. Monitoring efforts will continue on an annual basis focused on the detection of any new invasions of Asian carp. New biological information collected through Great Lakes basinwide sampling will address key gaps in the existing body of knowledge on the distribution and habitat requirements for Bighead, Silver, Grass, and Black Carp, especially for mid- to large-scale nearshore and open-water environments in North America.

4.2.2 Great Lakes States' Asian Carp Control Efforts

State agencies within the Great Lakes Basin have identified and continue to address the threat of aquatic invasive species (AIS), including Asian carp, in their respective aquatic resource management strategies. State fishery managers and policymakers coordinate closely within and between their jurisdictional boundaries, working through existing multiagency collaborations and governance bodies such as the Great Lakes Fishery Commission to address key issues. Priority activities focused on Asian carp are identified in many state AIS management plans, and include field surveys and monitoring to support early detection, development and implementation of Asian carp species risk assessments, rapid response simulations and other exercises, law enforcement actions, and public/stakeholder outreach focused on prevention and detection. Many of these efforts are part of a multi-state network of complementary actions, including tools such as regional mutual aid agreements for rapid response, if needed, and include collaboration with U.S. and Canadian federal and provincial resource management partners. Actions are included in state AIS or Asian carp-specific plans. Within the U.S., states continue to lead the way in the direct management of grass carp within their jurisdictional waters, guided by their respective regulations for the species.

Additional information on Asian carp management plans and activities for individual Great Lakes States can be found at:

- http://www.michigandnr.com/PUBLICATIONS/PDFS/ifr/ifrlibra/Special/Reports/sr60/SR60.pdf

- http://files.dnr.state.mn.us/natural_resources/invasives/carp-action-plan-draft.pdf
- http://www.dec.ny.gov/docs/fish_marine_pdf/draftnyaisplan14.pdf
- http://ohiodnr.gov/portals/0/pdfs/invasives/asian-carp-tactical-plan-2014.pdf
- http://fishandboat.com/ais/ais-action-asian-carp.pdf
- http://dnr.wi.gov/news/mediakits/mk_carpcontrol.asp

Additional information on Aquatic Nuisance Species Task Force-approved AIS management plans for individual States can be found at:

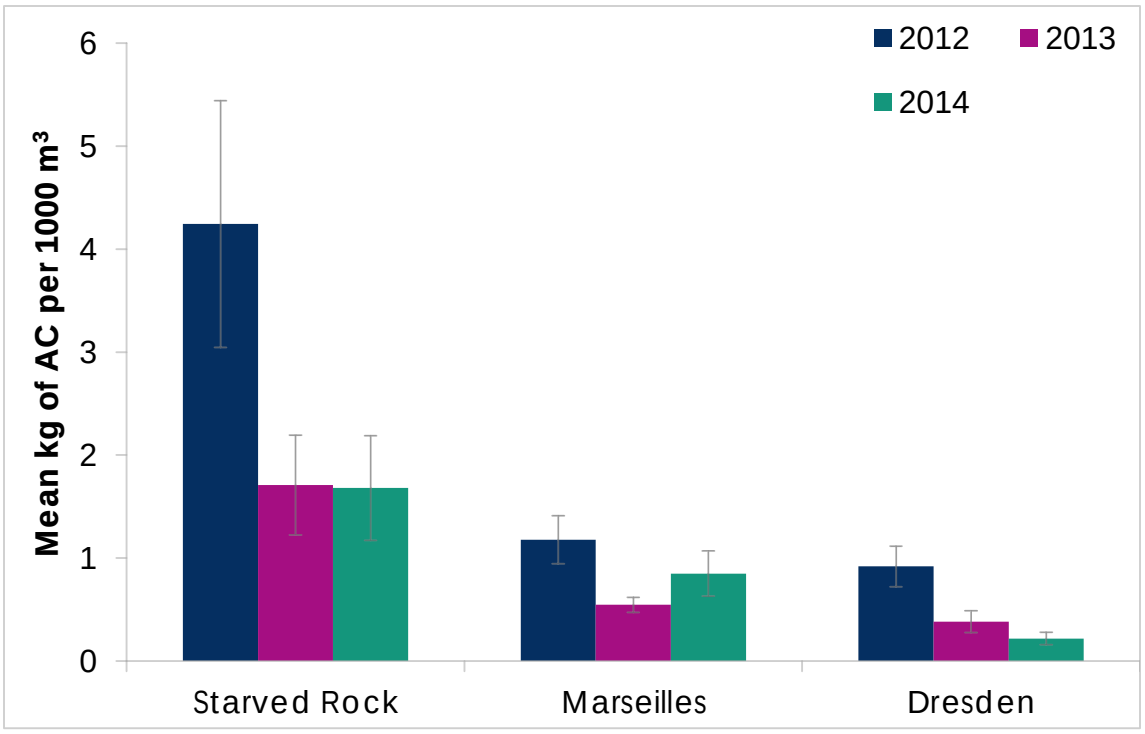
- http://www.anstaskforce.gov/stateplans.php

4.3 Illinois River Strategy and Lessons Learned

Although background information on fish populations of the upper Illinois River was being gathered by researchers and Illinois DNR, research on Asian carp was focused on small numbers of fish tagged in the upper river. With development of the ACCRCC's MRWG monitoring plans in 2010, efforts were increased to gain additional information on Asian carp presence both in the CAWS (areas between the electric barrier system and Lake Michigan) as well as those areas of the CAWS, Des Plaines River, and upper Illinois River immediately downstream of the barrier. These efforts include agency netting activity using multiple techniques, electrofishing, and contracting fishers to remove fish below the electric barrier system.

With information that Asian carp above the barrier system are currently extremely low or non-existent, efforts have been increased below the barrier beginning in 2013 to maximize the opportunity to detect subtle changes in the leading edge of the population (as noted in Figure 5). To date, no significant movement upstream has been noted and no Bighead Carp or Silver Carp have been captured in Brandon Road or Lockport Pools. Contracted fishing efforts have become more efficient. With consistent contracting from 2011 to 2014, a total of nearly 3 million pounds of Asian carp have been removed from the Starved Rock, Marseilles, and Dresden Island pools of the Illinois River. Significant reduction in the population of Asian carp has been noted by hydroacoustic surveys (see Figure 10).

Figure 10. Asian Carp Biomass Estimates



Southern Illinois University hydroacoustic estimates of Asian Carp biomass (expressed as kg of fish per 1000 m3 of water sampled) for the three reaches of the upper Illinois River

Over the past 4 years, integration of technology and fish removal has allowed for a more efficient operation.

Concurrent with the work on the upper Illinois River, the lower Illinois River Asian carp population has been estimated (2010 to 2014). The projects evaluated how efficient commercial fishing could be in controlling Asian carp populations using data on demographics (size and species, quantity in different areas, etc.), fish movement, spawning times and factors, and source populations. The study concluded:

- Asian carp abundance appears to have increased in 2014, particularly in the La Grange reach; successful recruitment was also apparent.
- Asian carp detections in lock and dams during 2014 were generally higher than in 2013, and more downstream movement was observed. Fourteen fish attempted to pass through the Dresden Island Lock and Dam. Thirteen Asian carp were detected in the Starved Rock lock chamber, with five making successful downstream passages. A total of 14 Asian carp moved through the Peoria lock chamber, while 18 made it through the La Grange lock chamber.
- No fish that were tagged below Starved Rock Lock and Dam have ever been detected moving upstream through that lock chamber.

- Similar to 2013, increased movement occurred out of pit areas within the lower Illinois River in mid-May when temperatures reached 18◦ Celsius (64.4◦ Fahrenheit) and river discharge spiked.
- Continued contract harvest (above Starved Rock Lock and Dam) plus intensive commercial harvest in the lower Illinois River may reduce density, potential recruitment, and perhaps immigration of Asian carp and their hybrids toward the electric barrier system in the Lockport Pool.

4.3.1 Illinois River Assessment

In 2015, Illinois DNR will advance its monitoring efforts and begin developing insights into the strategies for addressing Asian carp in the Illinois River. The primary objective will be to understand population dynamics of Asian carp that would give insight into the ability of directed harvest and other control measures to reduce overall populations within waters connecting to the Great Lakes and reduce movement of Asian carp upstream toward the CAWS. Using harvest and stock and recruitment variables in the upper Illinois River, Illinois DNR will be further developing dynamic models to forecast and predict effects of harvest, other control efforts, and breadth of Asian carp populations. The project will specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement of Asian carp.

Three years of hydroacoustic surveys (fall 2012, 2013, and 2014) have been completed throughout the Illinois River by Southern Illinois University. Protocols have been developed and refined so that surveys are analyzed in a comparable fashion to provide replicate annual Asian carp population estimates. Analysis indicates that Asian carp density and biomass in the upper Illinois River were highest in 2012 and have decreased in all three reaches in subsequent years

During the same period, shifts in Asian carp size structure to smaller fish, generally consistent with the removal of larger individuals, were also apparent in the upper Illinois River. The observed population changes may suggest signs of a response to commercial fishing. Inclusion of hydroacoustic population estimates from the lower river will allow stronger conclusions to be made regarding the effect of harvest and environmental conditions on the Asian carp population.

This information has been valuable in evaluating the threat of fish moving toward the electric barrier system as well management and control efforts. This focused effort has produced a data-rich evaluation of where Asian carp populations occur and gauge the success of removal operations. This evaluation may also be used to refocus efforts, as natural processes and overfishing may cause shifts in population structure and location.

4.3.2 2015 Illinois River Control Strategy

The overall strategy in Illinois River is to provide robust Integrated Pest Management in the Upper Illinois River, combining technologies and traditional fisheries tools to identify locations of Asian carp individuals and populations, with the ability to detect changes

in these boundaries. Also, reducing the population to the greatest extent practicable by contracted removal upstream of Starved Rock is critical. In addition, the following are important elements of the strategy:

- Provide relative abundance of lower Illinois River populations as a threat to move into the Upper Illinois River.
- Provide location information for small Asian carp in the upper or lower reaches of the Illinois Rivers.
- Encourage the commercial removal in other appropriate waters of the State of Illinois to reduce migration toward Lake Michigan.
- Work collaboratively with other agencies to evaluate the potential for additional barriers and deterrents locations within the Illinois River, including those being evaluated at Brandon Road Lock and Dam and Starved Rock Lock and Dam.
- Work collaboratively with other agencies to evaluate new technologies and tools for catching or removing Asian carp.
- Develop technologies to share real-time movement of fish (both Asian carp and surrogate species) in critical areas of the Upper Illinois River and CAWS.
- Continue to support response capacities through training and Incident Management teams for future needs as practicable.

4.4 Electric Barriers

The USACE electric dispersal barrier in the Chicago Sanitary and Ship Canal (CSSC) operates to prevent upstream fish dispersal from the Mississippi River Basin to Lake Michigan.

Since USACE began operation of the first electric barrier in the CSSC as a demonstration project in 2002, efforts to create a more effective and reliable fish deterrent technology have resulted in a redundant system of electric barriers with increased capacity.

The system currently consists of three barriers: the demonstration barrier, Barrier IIA, and Barrier IIB. Construction of a fourth barrier is under way. This action will effectively upgrade the demonstration barrier to a permanent facility, as authorized in the Water Resources Development Act of 2007. Completion of this fourth barrier, known as Barrier I, will signal the completion of construction on the CSSC electric barriers.

In potential future year actions, the USACE focus will shift from design and construction to operation and maintenance of the electric barriers in the CSSC. In addition to regular operation and maintenance, monitoring efforts such as the telemetry program are expected to continue, along with research to improve the efficacy of the barriers.

Barge Fish Entrainment Study

Numerous studies have been conducted to examine fish behavior and abundance directly within and adjacent to the electrical dispersal barrier in the CAWS (see http://www.fws.gov/midwest/fisheries/carterville/didson-barge.html for reports). Studies include: 1) examining the response of surrogate fish (non-Asian carp) to the electrical field while being pulled through the barrier in cages, 2) using

underwater SONAR-enhanced video cameras to count and observe the behavior of wild fish in and adjacent to the barriers, 3) using traditional fisheries hydroacoustics to evaluate fish presence, abundance, and distribution in the area adjacent to the barriers on an ongoing (daily, throughout multiple seasons) basis, and 4) studies of fish movement over time using radio tracking (telemetry).

Building upon this previous work, a series of studies was designed and is being conducted to evaluate the likelihood that barges transiting through the CAWS could inadvertently entrain (carry) live Asian carp through the electrical barrier system. The risk of fish being present and entrained is likely highest during late spring through fall, as data from existing research has demonstrated the higher density and overall movement of fish within the CAWS, including Asian carp, due to higher water temperatures. Research on the impacts of the barrier's electrical field on fish towed through the barrier in open cages demonstrated that at optimal barrier power levels (implemented by USACE in 2011), all surrogate caged fish were stunned and incapacitated. However, results from field and laboratory research being conducted by the USACE, USFWS, and partners has demonstrated the potential risk of live fish being entrained between barges transiting through locks within the CAWS under a variety of barge configurations and speeds, and subsequently across the electrical barrier. Study results showed that certain configurations can create hydraulic pockets between barges that may entrain fish; and that the metal hulls of transiting barges may temporarily disrupt the strength and continuity of the electrical field, impacting its ability to effectively cover the entire water column at levels optimal for fish incapacitation.

Ongoing work will include additional testing using barges to examine entrainment dynamics of non-Asian carp in pockets caused by barge junctions (connection points), including conditions under which fish are entrained in these areas and how far they may be entrained and transported within a waterway.

4.5 eDNA

Field collection of environmental DNA (eDNA) has been used as an early detection surveillance tool since 2009 and is specified for use by the ACRCC in the Monitoring and Response Plan. eDNA is a surveillance method used to detect the genetic material of a specific target fish in the wild. Water samples collected from aquatic environments are processed and extracted genetic material is compared to known markers for Bighead and Silver Carp. Its high sensitivity makes eDNA ideal for use as an early detection monitoring tool for AIS. eDNA provides the ability to indicate "presence or absence" for Bighead and Silver Carp DNA in specific locations of a sampled waterway. Since 2009, partner agencies of the ACRCC have collected eDNA samples from the CAWS on an ongoing basis. USACE began processing efforts in 2009, these efforts transitioned to USFWS in 2013, where they continue today at the Whitney Genetics Laboratory in Onalaska, Wisconsin.

4.5.1 Research and Program Development

The Framework identifies a number of eDNA-related actions that have been completed or are currently being undertaken. These efforts build upon the now-completed eDNA Calibration Study (ECALS) and the Asian carp eDNA marker development identified below.

eDNA Calibration Study

ECALS was a multi-year, interagency collaborative (USACE, USGS, USFWS) study to improve the understanding and interpretation of the detection of Asian carp DNA in eDNA samples. eDNA surveillance programs seek to detect the presence of genetic material (DNA in cells sloughed off in slime, feces, or urine) extracted from water samples; the detection of genetic material is linked to the possible presence of Asian carp, but can also be present from alternate sources. Completed in 2014, ECALS produced technical reports as well as a final report on the probabilistic model (available on www.AsianCarp.us).

The final probabilistic model report summarizes efforts to resolve some of the ambiguity that surrounds interpretation of eDNA monitoring results in the CAWS, by developing a model that supports likelihood statements about the source of eDNA detected in water samples and the presence of live Bighead and Silver Carp upstream of the barrier. The major message was that, at lower concentrations, Asian carp target markers are difficult to detect, so the polymerase chain reaction (PCR) assay has a high false negative rate. This shortfall was resolved in 2015 with new markers for both Bighead and Silver Carp (discussed in next section). With respect to alternate sources of Asian carp eDNA in the CAWS, it was found that combined sewer overflows (CSOs) and navigation were likely to be the largest and most likely contributors of alternate source eDNA detected in monitoring samples.

In addition to other study components, ECALS included the development of new genetic markers for Bighead and Silver Carp. The goal of the marker development was to obtain a suite of markers that provide a range of analytical capabilities, including (1)

improved detection probabilities, (2) more efficient processing, (3) real-time quantitative PCR estimates of DNA abundance, (4) data on genetic variability (or "polymorphism"), and (5) some indication of the time since an eDNA sample was deposited by a target species.

A validation trial was completed in June 2014 to test the newly developed markers against the existing markers in use for Bighead and Silver Carp. The new real-time PCR markers outperformed the previously used markers for detectability of both Bighead and Silver Carp. Validation trials demonstrated that real-time PCR markers are more sensitive, accurate, and precise because they match more sections of the Bighead Carp and Silver Carp genome against genetic material collected in water samples. In addition, the use of PCR markers was demonstrated to be more efficient, providing advantages in time and cost savings, and reducing likelihood of in-laboratory contamination. These new markers have a higher rate of detection since they are less subject to inhibition or environmental factors that may "mask" the detection of DNA, such as algae, and therefore less prone to yielding false negative detections. These new markers increase confidence in the ability to use eDNA as an early detection tool for the surveillance of Bighead and Silver Carp in any water body, and were implemented for use as part of the eDNA Regional Monitoring Program in 2014.

4.5.2 Monitoring Strategy and Lessons Learned

Through 2014, eDNA was used as a regular weekly monitoring tool to help inform response decisions, including additional intensive and focused sampling, as specified in the MRP. In 2014, eDNA was used in the CAWS as well as other regions of the Midwest (Great Lakes tributaries, Upper Mississippi River, and Ohio River) as part of a comprehensive regional monitoring effort for Bighead and Silver Carp invasion. Results from eDNA testing are posted regularly on the USFWS Midwest Region website at http://www.fws.gov/midwest/fisheries/eDNA.html.

Between 2009 and 2014, more than 14,000 water samples were analyzed for Bighead and Silver Carp DNA over the Midwest Region. The USFWS's comprehensive basin-wide eDNA monitoring program spans the entire Midwest region to include the CAWS, Great Lakes, Upper Mississippi River, and Ohio River. The increased laboratory capacity at the USFWS highlights the success of the Whitney Genetics laboratory and efficiencies realized through ECALS.

eDNA sampling in the basin will follow the standard protocols outlined in the Quality Assurance Project Plan (QAPP): eDNA Monitoring of Bighead and Silver Carps (http://www.fws.gov/midwest/fisheries/eDNA.html). The QAPP is maintained by USFWS, and includes developments from the eDNA calibration study and other efforts the interagency laboratory network (USACE, USGS, and USFWS). USFWS will continue to work with the states, provinces, and other members of the Council of Great Lakes Fishery Agencies to identify where efforts should be focused to ensure sampling occurs within areas with the highest probabilities of Asian carp presence ((such as Maumee River/Bay, Sandusky River/Bay, and southern Lake Michigan).), based on habitat preferences and availability and other factors Sampling at these locations will follow a

probabilistic design targeting areas of eDNA accumulation. The USFWS Whitney Genetics Laboratory will continue to process all eDNA samples.

As described above, eDNA sampling in the CAWS will continue above the barrier annually as a level of vigilance as an early detection tool for the DNA of Bighead and Silver Carp, or their hybrids. New in 2015, the application of eDNA will be broadened by collecting eDNA data below the barrier and down into the invasion front to determine the amount of DNA present in the system with known abundances of Bighead and Silver Carp. Research will also evaluate its use as a potential indicator of spawning times and locations in areas where to confirm successful reproduction has not been confirmed using conventional gear alone.

Regular eDNA sampling has been conducted within the western basin of Lake Erie since 2012, when multiple samples tested positive for both Bighead and Silver Carp. This positive result triggered additional physical monitoring techniques, but not physical specimens were captured or observed.

4.6 Integrated Pest Management

The USGS efforts are focused on development of control tools and technologies, methods to improve the use on eDNA for detection, and risk assessment for Asian carp reproduction and survival. The overall strategy is to use an Integrated Pest Management (IPM) approach by combining the tools, knowledge, and information available to detect, aggregate, remove, control, and exclude Asian carp. As described by USEPA, "IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions, and controls." (http://www.epa.gov/agriculture/tipm.html)

Use of an IPM approach requires extensive knowledge of Asian carp life history to guide the control technology design, development, and application strategies. Understanding Asian carp spawning requirements, egg and larval fish development, feeding and habitat requirements at different life stages, and fish behavior and distribution helps more effectively develop targeted control tools and inform management actions. Information about the conditions in and near the water where the fish reside is another critical part of the picture. For example, USGS has developed a model (called FluEgg) that incorporates data and analysis of river conditions (such as flow velocity and temperature) and combines them with Asian carp life history information (such as egg size and density) to identify tributaries with high potential for spawning and egg survival. This tool can also be used to identify locations where management actions may be taken to temporarily alter water flow to cause eggs to settle to the river bed or create spawning barriers to decrease egg survival.

Figure 11. Integrated Pest Management Approach

In 2015, USGS scientists will analyze water dynamics and water quality at the current Asian carp population front located on the Illinois River in the Dresden Island pool to gain a better understanding of why the Asian carp are not moving farther upstream. In addition, USGS will be reaching out to states and other agencies to understand their research needs and discuss how the FluEgg model works and the types of information it can provide. A second article on FluEgg is expected to be published in spring 2015 and a webinar will be scheduled to share the results and information.

USGS has been working with partners to develop and test a number of Asian carp control tools that are part of the larger Framework "toolbox" that can be used to develop effective IPM strategies based on the needs of state, tribal, and federal resource managers. For example, in 2013 successful IPM efforts were conducted with USGS, the Illinois DNR, USFWS, and Southern Illinois University, integrating waterguns, attractants, fish telemetry, and commercial fishing.

As control technologies are developed and field tested, researchers are working toward tailoring these tools and methods to enable direct transferability outside the Great Lakes Basin, including the Upper Mississippi River and Ohio River Basins. Researchers are also considering how technologies and tools can be applied to control other invasive species in the future. These technologies are described below.

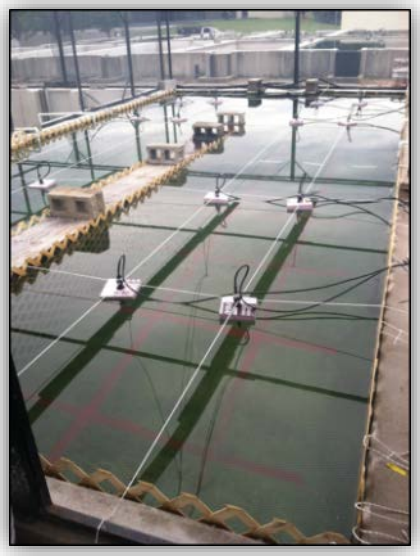
4.6.1 Waterguns

Watergun testing began in the spring of 2013 to examine effects on fish behavior and the ability to deter Asian carp. In 2014, scientists found a two-watergun setup altered fish behavior and documented that fish avoided and moved away from the waterguns when they were fired. The tested configuration of waterguns, however, was not a complete barrier to fish movement, as some tagged Asian carp were able to pass through areas where pressure gradients were reduced. As a result, scientists are refining their strategy for the 2015 field season. Six new waterguns will be used that will fire faster than the previous waterguns and at shorter intervals between firing, resulting in few low pressure areas. Scientists will collaborate with USFWS and Illinois DNR during the water gun trials and deploy a static water gun barrier with acoustic telemetry and fixed hydroacoustic monitoring to track behavioral responses of fish.

USGS has also been working closely with USACE to measure the effects of the pressure waves created by the waterguns when they are fired to ensure they do not cause damage. In potential future years, USGS will be working with USFWS, USACE, and state partners to identify effective strategies for watergun deployment and to transfer this technology to management agencies as appropriate.

4.6.2 Carbon Dioxide

Another technology being field tested in 2015 is the use of carbon dioxide as a barrier to Asian carp movement. The USGS, USACE, and the University of Illinois at Urbana-Champaign are collaborating on research to examine CO_2 effects on fish behavior. In 2014, a study pond was set up to simulate the downstream approach channel to a lock chamber, and a CO_2 barrier was created by infusing CO_2 into the pond. Scientists tracked fish response using an acoustic telemetry system and found that fish avoided areas of elevated CO_2. In 2015, USGS scientists and partners will be conducting a large-scale, open-water evaluation of CO_2 as an Asian carp control tool using both acoustic telemetry and hydroacoustics systems to track fish and assess how the CO_2 barrier affects their behavior. USGS will also continue to work with USFWS to examine effects on native mussels. Based on the results of CO_2 field testing, scientists will further refine this technology with an eye toward flexibility for field deployment. USGS will also provide CO_2 testing and support to USACE, as strategies are considered to address GLMRIS recommendations. In addition, USGS is working with USEPA and USFWS to complete the CO_2 registration process following the USEPA chemical registration and Section 7 Endangered Species Act (ESA) requirements.



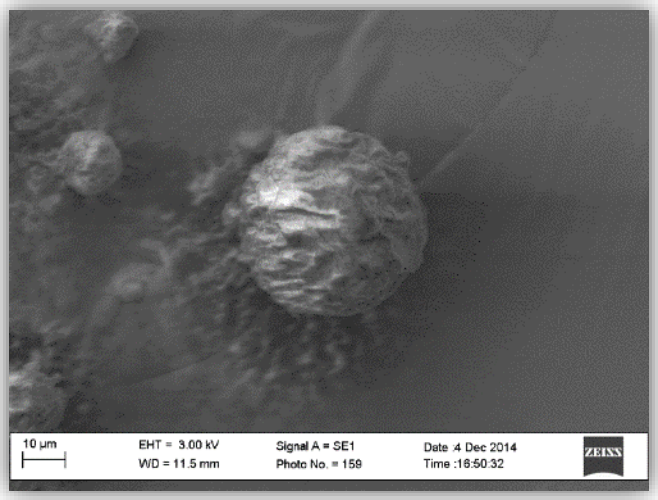
USGS CO2 study ponds

4.6.3 Chemical Attractants

USGS scientists have found that Asian carp have a strong attraction to certain algal mixtures that can be conditioned into feed. As mentioned previously, the attractants were part of an IPM strategy that also included waterguns, fish telemetry, and commercial fishing. Building on the success of that integrated effort, USGS and the Illinois DNR collaborated on a study in 2014 to examine the use of attractants with commercial and other types of fish netting gear to increase catch rates. Some additional testing will be done in 2015, and there is interest from other states outside the Great Lakes Basin that want to use attractants as a way to locate Asian carp for tagging. USGS is also examining the use of attractants with microparticle application. The approach will be to condition Asian carp to feeding on an algal mixture and then apply microparticles containing the fish toxin antmycin to assess the effectiveness of the microparticle treatments. Scientists are also working with the University of Minnesota, Duluth, to incorporate sound with the feeding trials to evaluate its effectiveness as a fish attractant. Future actions may include, reaching out to partners and communicating results.

4.6.4 Microparticles

USGS scientists have developed and tested microparticles in the laboratory that are capable of delivering the fish toxin antimycin to Asian carp. In 2014, scientists evaluated the toxicity of antimycin microparticles to establish exposure rates needed to control Asian carp while minimizing effects on non-target native fish, mussels, and invertebrates and examining microparticle degradation. Initial results suggest the oral delivery formulation will selectively deliver the piscicide antimycin-A to Asian carp and not to largemouth bass or bluegills.



Magnified view of microparticle

In the spring of 2015, scientists will be conducting pond trials with the new microparticles in combination with algal attractants. Scientists have found that the fish are strongly attracted to the algae as a food, so it will be co-applied with the microparticles to draw the fish in and condition them to feed. They will also evaluate microparticle efficacy, effects on Asian carp, and effects on non-target species. USGS is also working with the Illinois DNR to identify isolated locations (completely disconnected from the waterway) for field testing in the fall of 2015, pending permitting, and will also utilize a mobile USGS laboratory for streamside testing. The strategy for field tests will be based on the results of the spring pond trials. Future actions may include, continuing to work with USEPA and USFWS to complete the microparticle registration process to obtain approval for microparticle application. USGS is also initiating development of an antimycin-delivery system focused on Grass Carp. Unlike Bighead and Silver Carp that filter feed, Grass Carp eat aquatic plants, thus requiring a different microparticle design.

4.7 Enforcement and Outreach

At the federal level, enforcement of illegal trade and interstate transit of Asian carp is carried out by the USFWS under the Lacey Act (18 U.S.C. section 42), which prohibits interstate movement of live organisms that are on a recognized list of injurious species. Currently, Silver, Bighead, and Black Carp are listed as injurious wildlife. Bighead Carp were most recently added to the list of injurious species in 2011. Although the Lacey Act prohibits movement of live Asian carp across state lines, it does not prohibit Asian carp aquaculture or possession of live Asian carp. Each of the Great Lakes states and the province of Ontario has made it illegal to possess live Asian carp within their jurisdictions; however, Asian carp aquaculture facilities (fish farms) in parts of the southern United States remain active. In addition, the scope of the Lacey Act's interstate transport prohibition recently has been called into question. On May 12, 2015, the United States

District Court for the District of Columbia ruled that Plaintiffs in United States Association of Reptile Keepers Inc. v. Jewell are likely to prevail on their claim that transport between states within the continental United States is not prohibited under the Lacey Act, except for transport to or from the District of Columbia.

In spite of the federal and state laws, live Asian carp remain highly valued at fish markets, and the illegal movement of Asian carp and non-compliant fish dealers persists. Enforcement of U.S. and Canadian laws regulating movement and possession of live fish is essential to prevent establishment of Asian carp in the Great Lakes Basin. For example, the Great Lakes Fishery Commission's Lake Erie Committee believes that prevention efforts are the most important investment for protecting the Great Lakes from potential effects of Asian carp. The Great Lakes Law Enforcement Committee has consistently advocated for better enforcement and tougher laws governing interstate movement of live Asian carp. The committee has facilitated training of officers to identity Asian carp and other key invasive fishes.

The USFWS continues to expand surveillance and enforcement of the illegal transportation of Asian carp and other federally listed invasive species. Border locations are of particular concern and targeted surveillance actions, including use of a deployable X-ray van, are being expanded in areas of known activity. The USFWS is working closely with Great Lakes state partners to control the spread of invasive species, including Asian carp.

In 2013, USFWS increased training of law enforcement personnel and partner agencies using video and informational brochures to assist law enforcement officials in identifying Asian carp and transport vehicles used in moving these fish across state lines.

In 2014, USFWS Office of Law Enforcement continued its efforts, working closely with conservation law enforcement officers from the Midwest States. Efforts focused on continued training efforts for invasive species detection as well as coordinated enforcement efforts focused on the interstate transport of Asian carp and other invasive and injurious species.

A portion of 2014 USFWS law enforcement funding was also used to assist USGS in development of a hand-held eDNA probe to assist USFWS Fisheries and Law Enforcement staff with real-time, on-site inspections of facilities and shipments that may contain Bighead and Silver Carp. Funds were also used to cooperatively develop Black Carp eDNA markers that could be used in genetic-based, law enforcement surveillance efforts or inspections in the future.

The Illinois Invasive Species Unit was formed in July 2012 to create an effective enforcement component of Illinois DNR's invasive species program. The unit consists of two officers with more than 20 years of combined law enforcement experience with the Illinois Conservation Police. The Invasive Species Unit is fully dedicated to enforcing state and federal regulations to prevent the spread of invasive species and is a member of the multi-agency Asian Carp Task Force established December 2012 to combine enforcement efforts throughout the United States.

Illinois DNR has increased officer presence and enforcement activities related to Asian carp, which has proven successful in promoting open dialogue among store owners, the public, and enforcement officials. Throughout 2014, Illinois DNR staff and Conservation Police officers performed on-site enforcement through informal site visits at fish processors, fish markets, and retail food establishments. Commercial fishing has been identified as a major tool to reduce the wild population of carp in the nation's large rivers. Enforcement efforts support that the fishers are abiding by the laws regarding catch and transport of wild Asian carp.

The State of New York updated its state regulations to restrict possession, transportation, and sale of Asian carp and other fish dangerous to indigenous fish populations. The most recent revisions to the regulations ban importation, possession, and sale of live Bighead Carp in the entire State of New York. These new regulations are consistent with federal actions that ban all interstate transportation of live bighead carp.

The Michigan DNR created a specialty unit formed within the Law Enforcement Division called the Great Lakes Enforcement Unit. This unit's primary focus is aquatic species enforcement throughout the entire Great Lakes Basin surrounding Michigan. The Great Lakes Enforcement Unit is dedicated to the detection and prevention of injurious aquatic species and represents the Michigan DNR Law Enforcement Division as a member of a multi-state Aquatic Invasive Species special task force. Each year, the Great Lakes Enforcement Unit conducts hundreds of inspections throughout the State for the commercial fish industry, including commercial fishing vessels, wholesale fish businesses, and retail fish markets. These inspections target the live possession of AIS including Asian carp. These inspections offer a unique opportunity to further expand education and outreach efforts in preventing the introduction or spread of invasive species.

Michigan conservation officers work closely with other state and federal partners to minimize pathways that may be susceptible to invasive species introduction. These cooperative efforts multiply enforcement coverage across the state and international boundaries, which in turn enhances the ability to stop illegal shipments of Asian carp and other prohibited species from reaching Michigan.

The cooperative efforts of Michigan's Great Lakes Enforcement Unit, USFWS, and National Oceanic and Atmospheric Administration (NOAA) Office of Law Enforcement resulted in the successful prosecution of an Oregon-based company that was violating a Michigan Fish Disease Control Order. In 2014, the company illegally marketed uncertified Pacific Herring fillets to be used as bait in Michigan, which could have introduced Viral Hemorrhagic Septicemia into Michigan waters. Quick response by the Great Lakes Enforcement Unit was critical to the seizure of several hundred packages of bait, therefore thwarting any such risk.

Another cooperative effort by Michigan Conservation Officer's and the USFWS was a covert investigation effort where minnows were purchased from 40 retail bait dealers throughout the state. The minnows were determined to have originated from out-of-

state wholesale businesses. Michigan Conservation Officers inspected the samples purchased and did not observe any Asian carp species from the minnows purchased.

Additionally, the Great Lakes Enforcement Unit is responsible for training others in the identification of AIS. In 2014, Michigan Conservation Officers provided identification training to 23 new Michigan Conservation Officer recruits and 24 tribal Conservation Officers within the Great Lakes Indian Fish and Wildlife Commission. Tribal officers have enforcement authority over tribal fishing issues of the 1842 Treaty area, which spans through Michigan, Wisconsin, and Minnesota. In 2015, the Michigan DNR Great Lakes Enforcement Unit officers will continue to conduct training for the current recruit school in AIS identification.

The Michigan DNR Law Enforcement Division's Great Lakes Enforcement Unit is currently working to rewrite the entire state statutes regarding commercial fishing, wholesale operations, and movement of bait and fish stocks to better protect Michigan from the spread of injurious species and diseases.

4.8 Integrated Preparedness and Response

To further integrate preparedness among ACRCC stakeholders for coordinated actions, the USEPA has developed an Incident Command System (ICS) training course for invasive species response efforts. This 1- to 2-day course provides the knowledge required for service as lead response or support personnel in an invasive species response that may require multi-jurisdictional resources and agency coordination. The course is intended for agencies and groups that participate in an AIS-specific rapid response and may or may not have previous experience with ICS. The group exercise as part of the class promotes effective communication and collaboration, which are essential during rapid response incidents. Team training with multiple agencies is ideal to simulate the complexity of most incidents.

The goals of this course are to:

- Gain a general understanding of the ICS organizational and operational framework through a brief ICS instructional presentation
- Demonstrate the ability to effectively conduct internal notifications, coordinate across agencies, and use resources from multiple entities
- Gain an understanding of the importance of jurisdictional authority based on agencies' missions and mandates, and species location
- Organize and initiate a successful small-scale, on-water AIS assessment through group discussion and course exercises
- Discuss the differences in operations and resources for various types of AIS rapid response efforts

USEPA has combined this course with a tabletop exercise using an AIS scenario to introduce agencies to response-related situations and inter-agency coordination. This

course offering will continue on an as-requested basis. Additional, more in-depth ICS trainings are available if requested, depending on group size and trainer availability.

The Great Lakes Water Quality Agreement (GLWQA) Annex 6 Subcommittee is taking a leadership role in increasing the capabilities of stakeholder agencies and organizations basinwide for preventing, controlling, or eradicating AIS to protect the Great Lakes Basin through plan development, training, and exercises. The United States and Canadian agencies at the local, state, provincial, tribal, and federal levels, along with other stakeholder organizations, are developing methods to deploy their expertise and capabilities in a unified and coordinated manner to detect, prevent, protect, respond to, and recover from the introduction of AIS the Great Lakes Basin. The Annex 6 subcommittee was formed as a joint initiative between the United States and Canada, led by USFWS and DFO-Canada. The Annex 6 Rapid Response Task Team was formed as part of the subcommittee to further develop a Binational AIS response plan and carry out training and exercises among the stakeholder agencies. USEPA co-chairs the Rapid Response Task Team and has plans to conduct multiple bi-national preparedness exercises around the Great Lakes Basin. The first exercise was conducted in 2014, with plans to conduct three additional exercises in future years.

By the end of FY 2014, state plans that included rapid response capabilities had been completed by all eight Great Lake states and ICS or variations of this system have been adopted by each state. State agencies are now (since FY 2014, under their GLRI state AIS grants) required to annually either convene a rapid response exercise, or to conduct one rapid response action. Exercises are required to increase state agency preparedness, capabilities, and capacities relating to invasive species detections in the Great Lakes. To date, the ACRCC has taken part in 38 responses and exercises to bolster capabilities.

5.0 CANADIAN ASIAN CARP CONTROL EFFORTS

The federal Fisheries and Oceans Canada, the provincial Ontario Ministry of Natural Resources and Forestry (OMNRF), and the Quebec Ministère des Forêts, de la Faune et des Parcs are key Canadian agencies that are working as members of the ACRCC toward monitoring and control of Asian carp. The efforts of these agencies are being presented for the first time as part of this Framework; thus, detailed information is identified in this section.

5.1 FISHERIES AND OCEANS CANADA – FEDERAL ACTIVITIES

Fisheries and Oceans Canada (DFO) has undertaken a wide variety of efforts to control and prevent the spread of Asian carp into Canadian waterways that are presented in the following sections.

5.1.1 Targeted Traditional Gear Monitoring

DFO developed and implemented an early detection and monitoring program for the Canadian side of the Great Lakes. Sites at risk in Canadian tributaries were identified in the "*2011 Binational Ecological Risk Assessment for Asian Carps in the Great Lakes*" for integration into the long-term monitoring program. The monitoring program was initiated in 2013 and will continue through the 2016 field season (approximately May through November). In 2013, 24 sites were assessed and, from these, a total of 22 early detection sites were established in tributaries and wetlands areas in Lake Erie, Lake Huron, and the Huron-Erie corridor. These 22 early detection sites will be revisited each year of the program (2014 to 2016 field seasons). In 2014, the program expanded to include 13 additional early detection sites in Lake Erie, Lake Huron, the Huron-Erie corridor, Lake Superior, and the western end of Lake Ontario, for a total of 35 sites. Further sites in eastern Lake Ontario and the Huron-Erie Corridor that are predicted to be at risk will be scouted for their suitability in the 2015 to 2016 sampling seasons, while four previously sampled sites will be removed from the monitoring program, as they were deemed to have lower suitability than predicted.

Field sampling in 2013 was completed using a variety of gear, including bag seine, boat electrofishing, fyke nets, and trammel nets. For 2014 and beyond, the program refined electrofishing sampling techniques and incorporated 6-foot hoop nets, trap nets, and tied-down gill nets. All sampling gears caught surrogate species for Asian carp. Additional gear will continue to be introduced to the program to complement those currently being deployed. In 2013, DFO Burlington field crews sampled 195 sites and captured a total of 15,849 fishes, representing 73 species. In 2014, crews sampled 590 sites and captured a total of 32,054 fishes, representing 84 species. In the 2015 to 2016 field seasons, sampling effort is anticipated to increase slightly from 2014 levels, with a continued focus on at-risk locations.

5.1.2 eDNA Monitoring

DFO developed the laboratory capacity in 2013 and 2014 in both Burlington, Ontario (Asian Carp Laboratory), and Winnipeg, Manitoba (eDNA Laboratory), for filtering, extracting, and analyzing eDNA for Asian carp. In 2013 and 2014, eDNA analyses were conducted surrounding response events. Research is being initiated by DFO to complement work done elsewhere to better understand the use of eDNA as a monitoring tool. Results from this research will guide decisions on the use of this tool in the monitoring program for field seasons 2015 to 2016.

5.1.3 Response

DFO has developed the capacity in the Burlington, Ontario, Asian Carp Laboratory for rapid testing of ploidy of any captured Asian carp in Canada. DFO was involved in two response activities in 2013 and again in 2014.

In April 2013, an angler-captured Grass Carp in the Grand River was taken into possession by DFO. The species was verified, and an active search for additional specimens in the area of capture was conducted. Traditional sampling and eDNA both suggested no additional specimens were in the area.

In August 2013, a Grass Carp was captured by DFO staff sampling in the area of the April capture site as part of the early warning surveillance program. Response protocols, involving intensive netting and boat electrofishing efforts, were immediately invoked. eDNA sampling was also conducted at the time of capture and several days after capture. Both sampling techniques suggest no additional specimens were present. Both specimens were triploids with the April specimen estimated to be 16 years of age and the August specimen to be 9 years of age.

In August 2014, eDNA samples collected by the OMNRF on July 7 and August 14 in Ausable River came back positive for Silver Carp eDNA and Silver Carp and Grass Carp eDNA. Response protocols, involving additional eDNA collection, intensive netting and boat electrofishing efforts, were invoked based on sequential positive eDNA detections in one location. Response activities resulted in no additional positive eDNA samples and suggested no live specimens were present.

In September 2014, a Grass Carp was captured by DFO staff sampling in the area of the 2013 capture sites as part of the early warning surveillance program. Response protocols, involving intensive netting and boat electrofishing efforts, were immediately invoked. DFO staff was quickly able to determine that the specimen was triploid. Response activities suggested no additional specimens were present.

For 2015 and beyond, DFO will continue to respond, in conjunction with its partners, to Asian carp captures in the Canadian waters of the Great Lakes. ICS and response training for Canadian agencies is planned for 2015. On-line, in-class, and on-the-water training will be included and response requirements will be well-defined. By 2015, in conjunction with DFO partners, an equipment inventory database will have been developed to enable rapid response activities.

5.1.4 Research Activities

DFO's Asian Carp Program focuses mainly on research related to prevention, early warning, and preparedness for response to potential Asian carp detections in Canadian waters.

Asian Carp Movement Study

The Asian Carp Program is currently examining the risk of direct movement of freshwater fishes through the Welland Canal and St. Marys River using telemetry studies that began with a pilot project in 2012 and continued in 2013 and 2014. As the Welland Canal and St. Marys River are direct pathways connecting Lake Ontario and Erie, and Lake Superior and Huron, this research will assess the likelihood of Asian carp movement through the connecting channels and identify the location and timing of monitoring and controlling activities for AIS, including Asian carp. To date, nearly 200 large-bodied fishes have been tagged and released in the area. Tracking these fish from 2012 to 2014 resulted in 911,439 detections. Analysis will be conducted in 2013 to inform additional data needs. The information collected will help to identify areas where fish movement occurs, areas where movement could best be controlled, and ecological characteristics of fishes that are more likely to spread through canals.

Control Technologies

In dealing with invasive species, preventing introduction, spread, and establishment is considered the most effective management options. DFO's Asian Carp Program is evaluating several non-permanent barrier control technologies in deterring fish movement using controlled study environments and laboratory studies.

Starting in 2013, 222 fish have been tagged and their movements will be tracked with a 3-dimensional system in a large controlled study environment in Burlington, Ontario, to assess their behavior and reaction to various control technologies. To date, data have been collected for the following technologies: pressure, low-frequency sonar, and bubbles. In 2015, underwater speakers, alarm pheromones, and carbon dioxide will be studied and the ability of these mechanisms to work together toward an IPM system will be evaluated. In 2016, effectiveness of an electrified net will be studied. Evaluation of these non-permanent barrier technologies in managing fish movement will be provide management options in preventing the spread and reducing the recruitment of Asian carp.

eDNA Research

Research is being initiated by DFO to complement work done in the U.S. to better understand the use of eDNA as a monitoring tool. With partners, DFO will conduct boating surveys to inform how eDNA may be transported between locations on boats and equipment. The eDNA research being conducted by DFO, provincial, and U.S. agencies will guide the operationalizing of eDNA within DFO as a monitoring and response tool.

A QAPP detailing the Asian carp eDNA monitoring process, which includes laboratory methodologies and quality control measures, was updated in 2014 by the USFWS eDNA

laboratory program. In 2015, the DFO eDNA laboratory program in Winnipeg will have implemented the new QAPP protocols, which includes improved eDNA assays for detecting Silver and Bighead Carp. DFO will continue to monitor for Grass Carp eDNA using assays developed at OMNRF. In 2014 and 2015, as part of an ongoing research plan, development of internal DFO SOPS specific to the Winnipeg laboratory, and supplemental to the QAPP, were initiated and will be put into practice prior to the 2015 Asian carp field monitoring program. DFO and partners will continue to develop and incorporate additional quality control and assurance measures to ensure reliability, reproducibility, and accuracy of outputs. Additional research has begun evaluating eDNA preservation methods to ensure optimal safeguarding of samples. Work has also begun to explore further improvements to eDNA extraction methods to increase efficiency and potentially improve detection of low copy number DNA.

For 2015 to 2016, research initiated in prior years will be completed and outputs collectively reviewed with DFO's provincial and United States counterparts. In addition, DFO research investigating methods to minimize the effect of inhibitory materials, which decrease the efficiency and accuracy of eDNA assays, will extend work under way at the OMNRF and the U.S. Identifying potential sources and pathways of sample contamination in the eDNA analysis workflow (filtration and molecular protocols) will continue, with results provided to both the Burlington and Winnipeg laboratories. To ensure that outputs can be readily examined by U.S partners, methods to harmonize reporting records (analysis summary statistics and results) will be assessed and incorporated.

Capacity building at the eDNA laboratory program in Winnipeg is also being expanded through an eDNA project being undertaken by an M.Sc. candidate at the University of Manitoba and under DFO's Research Affiliate Program (RAP). Objectives of that work include: (1) improvements to current techniques to reduce the effects of false negatives (not being able to detect a target organism even when one is present) and improve confidence in eDNA data; and (2) using second-generation sequencing techniques as a novel alternative approach to current eDNA methodologies to increase accuracy and efficiencies in eDNA detection and monitoring.

Preliminary investigations are also occurring regarding the application of eDNA techniques to rare species, which will be highly applicable to newly invaded species in low numbers below traditional detectability.

5.1.5 Outreach and Education

In partnership with two non-governmental organizations (Ontario Federation of Anglers and Hunters [OFAH] and the Invasive Species Centre) in Ontario, DFO is implementing outreach and education to stakeholders and the public in Canada. "Asian Carp Canada" has been branded, and its use on Twitter and Facebook began in 2013. The Asian Carp Canada website, www.asianCarp.ca, a counterpart to www.asianCarp.us, was launched in January 2015. The website contains information on activities under way by government and non-governmental agencies in Canada and will continue to grow in 2015 through 2017. Outreach materials, presence at trade shows, community-

based workshops, and webinars were developed in 2014. In 2015, augmentation of the Royal Ontario Museum's biodiversity gallery will include information on the threat of Asian carp to educate museum visitors.

5.1.6 Enforcement

The Canadian Federal Government released proposed national AIS regulations in December 2014. These regulations would allow for the prohibition of import, transport, possession, sale, and control of high-risk AIS. These regulations will complement any current provincial regulations and strengthen Canada's collaborative ability, along with the United States, to protect the Canadian waters of the Great Lakes from AIS, including Asian carp.

DFO will continue to provide support through 2017 to enforcement agencies in both Canada and the United States to prevent movement of live Asian carp through trade.

5.2 Asian Carp Control Efforts in Canada: Ontario

OMNRF has the lead provincial role to prevent the introduction, establishment, and spread of AIS and their negative effects on Ontario's environment, economy, and society. OMNRF's responsibilities include:

- Leadership and coordination of inter-agency activities to prevent, detect, respond to, and manage the threat of AIS;
- Development and enforcement of legislation and policy;
- Risk analysis;
- Response planning;
- Monitoring and science;
- Development of management measures; and
- Communications and outreach to the public.

5.2.1 Surveillance and Monitoring

After positive eDNA samples in 2012 on the U.S. side of Lake Erie, the OMNRF increased its monitoring activities in Canadian waters of the Great Lakes and its tributaries. Efforts focus on monitoring and assessing Lake Erie, Lake St. Clair, the Detroit River, the St. Clair River, and southern Lake Huron. eDNA is a key technique used for monitoring in these locations. OMNRF also conducts electrofishing in these locations, both to monitor for Asian Carp presence and to better understand the composition of fish species currently present. In addition, OMNRF collects samples from commercial fishing harvests within Lake Erie and has instituted a trawling program in the eastern and western basins of Lake Erie to monitor for Asian carp. A seining program has also been instituted in Lake St. Clair to monitor for Asian carp.

During the 2014 field season, 579 samples were collected and analyzed. In August 2014, OMNRF had had several positive eDNA detections for various Asian carp species in tributaries connected to the Great Lakes Basin. Locations for these detections included the Ausable River (Lake Huron tributary), Canard River (Detroit River Tributary), and the Grand River (Lake Erie Tributary). In response to these detections, both DFO, and the

OMNRF increased targeted surveillance efforts with additional eDNA testing and traditional netting and electrofishing gears. Follow-up sampling did not catch any live Asian carp of the type detected.

The commercial fishery has the potential to capture adult Asian carp. With approximately 33,000 kilometers (20,625 miles) of gill net effort on Lake Erie, commercial fishers are an important early detection mechanism for detecting the presence of Asian carp. In addition, OMNRF employs commercial fishery monitoring using a full Port Observer presence and commercial catch sampling program.

5.2.2 eDNA Research

eDNA research in 2014 focused on discriminating between detection failure and true absence, as well as testing and validating other eDNA markers and systems. Experimental eDNA trials with non-invasive species are being used to confirm taxonomic specificity and the spatial, temporal, and quantitative sensitivity of eDNA detection. In-year development and validation for Black Carp eDNA markers enabled surveillance for Black Carp as well as Bighead, Silver, and Grass Carp in 2014. Other research examined the persistence of target species DNA through water treatment systems. These various applications and combined results confirm the utility of eDNA as a reliable method for AIS detection.

5.2.3 Asian Carp Response Plan

OMNRF has developed a provincial Asian Carp Response Plan in partnership with DFO. The Asian Carp Response Plan outlines procedures for implementation of an emergency response if Asian carp are detected in Ontario waters. The province has undertaken several simulation exercises to test the plan and improve agency-wide preparedness. In 2015, the province continues its efforts to improve the plan based on new science and improved coordination with U.S. partners.

5.2.4 Outreach Activities

The Ontario-wide Invading Species Awareness Program has been a joint partnership initiative of the OMNRF and OFAH since 1992. The program focuses on the promotion of public awareness and prevention of the spread of invasive species. The program is also designed to track and monitor the occurrence and distribution of invasive species, including Asian carp. The program includes a toll free hotline (1-800-563-7711), and a website (www.invading species.com) hosted by OFAH. Recently, a web-based reporting and tracking system has been introduced called Early Detection and Distribution Maps Ontario, which also has a mobile app for Apple® and Android® devices. It is designed to allow users to quickly view and report invasive species sightings.

As part of the province's cooperative efforts with commercial fishers, specific Asian carp outreach materials have been provided to commercial fishers to assist in identification and reporting.

5.2.5 Regulations

In 2005, Ontario made it illegal to possess live Asian carp. Despite the law, between 2005 and 2013, 20 convictions resulted in more than $340,000 in fines and the seizure of more than 40,000 pounds of Asian carp.

In 2014, Ontario introduced proposed invasive species legislation. The proposed Invasive Species Act will enable a suite of provincial tools that will allow Ontario to take action, while continuing to work with partners and complement the role of the federal government in managing invasive species.

The new legislation if passed would:

- Provide a strong legislative framework to better prevent, detect, rapidly respond to and, where feasible, eradicate invasive species;
- Promote shared accountability for managing invasive species;
- Hold those responsible accountable for costs of control and eradication through strong penalties and cost recovery of expenses for managing invasive species; and
- Use a risk-based approach that considers the full range of threats, costs, and benefits to the environment, society and the economy.

5.3 Asian Carp Control Efforts in Quebec

Efforts to control Asian carp outside of the Great Lakes Basin are not within the scope of the ACRCC and therefore not discussed within the action items of this Framework. However, they are equally critical to controlling the Asian carp population throughout the United States and Canada and can ultimately affect the efforts taken within the basin. Some of the many efforts being undertaken and the federal and state level are discussed below. For example, outreach tools and materials developed for managing Asian carp in the Great Lakes Basin and provided through the www.AsianCarp.us website directly support efforts to manage Asian carp species in other watersheds in the United States, including the Upper Mississippi River and Ohio River basins. Additionally, field-based monitoring and rapid response strategies, tactics, and tools being developed through the leadership of the ACRCC and focused on protecting the Great Lakes watersheds may, ultimately, be applicable to managing the threat of Asian carp in other watershed throughout the United States, including those contiguous with the Great Lakes.

In Quebec, the Ministère des Forêts, de la Faune et des Parcs (MFFP) is responsible of the conservation and protection of the integrity and health of the biodiversity of aquatic and terrestrial Wildlife. MFFP is also responsible of managing sport fishing of freshwater and anadromous fish species. MFFP works in collaboration with other ministries, agencies, governments, jurisdictions, stakeholders, and partners to protect, restore, and sustain wildlife habitats and biodiversity. MFFP fulfills these mandates through planning, regulation, enforcement, scientific study, stocking, stewardships, and outreach.

MFFP is the provincial leading role to prevent introduction, establishment, and spread of invasive animal species. In aquatic ecosystems, the MFFP's responsibilities concern freshwater habitats included in Inland Waters and parts of the St. Lawrence River and its tributaries. MFFP's responsibilities also include leadership and coordination of interagency activities to prevent and manage the threat of AIS, development and enforcement of provincial legislation and policy, response planning, monitoring and science, development of management measures, and communications and outreach to the public. Specific MFFP activities are summarized in the sections below.

5.3.1 eDNA Sampling

eDNA sampling and analysis protocols have been tested since 2013 as a future Ministerial tool for early detection of invasive exotic and endangered animal species in aquatic habitats. In 2013, water samples were collected in several freshwater portions of the St. Lawrence River, including fluvial lakes (Lakes St-François, St-Louis, and St-Pierre). Asian carp were targeted in those analyses, as well as other AIS including Round goby and Tench). In 2014, the eDNA analysis protocol was further developed to better respond to the unique characteristics of the St. Lawrence River. In 2015, MFFP will continue its work on the use of eDNA analysis as an early AIS detection tool.

5.3.2 Rapid Response Plan

An Inter-ministerial rapid response plan on AIS is currently being drafted. Four ministries are involved in this plan: three provincial and one federal. The provincial Ministries are the MFFP, the Ministère du Développement durable, de l'Environnement et de la Lutte Contre les Changements Climatiques (MDDELCC), and the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ). The Maurice Lamontagne Institute, part of DFO ministry's research centers network, represents the federal entity involved in this plan.

This rapid response plan will help the ministries' responders react quickly when new AIS are detected or when an AIS already present is detected in a new area in the St. Lawrence River or inland waters. Asian carp are among the AIS targeted by the Inter-ministerial rapid response plan. This rapid response plan is identified and implemented in the St. Lawrence Action Plan 2011-2016. This action plan pools efforts and resources of multiple departments, ministries, and agencies of the governments of Canada and Québec as well as various stakeholders that share common objectives of conservation, restoration, protection, and development of the St. Lawrence river and its tributaries.

5.3.3 Action Plan

An Interministerial Action Plan on exotic invasive species (EIS) is currently being drafted. The two Ministries involved in this plan are the MFFP and the MDDELCC. This action plan will help the ministries' responders fight effectively against aquatic, terrestrial animal and plant EIS, prevent their introduction and propagation, acquire more information, and make recommendations about conducting risk analyses and outreach on EIS. It will also promote collaboration with other jurisdictions and ministries, as well as non-governmental organizations. The action plan arises from the Interministerial Strategy on

exotic invasive species and will target Asian carp, as well as other exotic invasive aquatic and terrestrial animals and plants.

Some of the actions targeted by the action plan will be: (1) developing a Code of Practice to prevent EIS introduction and propagation during field work; (2) promoting the Code of Practice to external partners and the public in general; (3) putting in place a network of information sharing on EIS; (4) establishing ministerial EIS early detection and surveillance tools; (5) developing environmental and economic risk analysis; (6) evaluating the feasibility of intervention analyses tools on EIS; and (7) developing EIS interventions protocols.

5.3.4 Strategy

An Interministerial Strategy on EIS is currently being drafted by the MFFP and the MDDELCC. The EIS strategy addresses both animal and plant concerns. The Inter-ministerial Strategy will target Asian carp, as well as other exotic invasive aquatic and terrestrial animals and plants. Prevention of EIS introduction and propagation, EIS surveillance and rapid response are among the issues presented in the Inter-ministerial Strategy. Fostering collaboration and information between governments and agencies, other jurisdictions, and non-governments partners, acquiring new knowledge, public outreach activities, and adapting the current regulatory framework will be part of the orientations also presented in the strategy.

5.3.5 Monitoring: Commercial Fisheries

Since 2007, an AIS early detection network, composed of 40 commercial fisher volunteers, works in collaboration with the MFFP. They report any exotic, unknown, or suspicious fish caught in their nets. The network operates over a 600 -kilometer stretch in the St. Lawrence River, and the fish caught are sent to the Ministry's experts for identification if necessary. The fishers have been informed and trained to identify Asian carp, among other AIS. They are aware of the risks and the threat that these species represent, and they will immediately contact the Ministry if a specimen is caught in their nets. Since the beginning of this network, two Chinese mitten crabs (*Eriocheir sinensi*), one Blueback Herring (*Alosa aestivalis*), more than 400 Round Gobies (*Neogobius melanostomus*) and 4,600 Tench (*Tinca tinca*) have been reported to the Ministry by this early detection network.

5.3.6 Monitoring: Fish Biodiversity Survey

Since 1995, an MFFP team, the Fish Monitoring network (FMN), has conducted annual surveys in various locations within the freshwater portion of the St. Lawrence River to monitor fish biodiversity. These monitoring activities do not specifically target AIS; but when exotic species are captured, the FMN adds the information to its database. Round Gobies, Tench, and Common Rudd have been observed in past years. Results of the FMN monitoring can be viewed on the St. Lawrence Global Observatory Website: http://ogsl.ca/en/.

5.3.7 Outreach Activities

Many outreach activities have been undertaken by the MFFP over the years. For example, a poster produced in collaboration with the MDDELCC, with information on boat and gear cleaning to prevent AIS introduction and propagation, as well as how to dispose of unwanted aquatic pets and other aquatic organisms, was made available to municipalities and the public. Asian carp are part of the AIS presented during outreach activities as threats to Quebec's aquatic ecosystems.

5.3.8 Sport Fishing and Boat Cleaning Activities

Outreach targeting sport fishery and anglers, as well as ice fishing, was carried out for 3 years, from 2012 to 2014, to provide information on the risk of AIS introduction and propagation by these activities. The outreach activities were conducted by teams led by MFFP experts together with nongovernmental partners (such as watershed organizations). These teams were promoting boat and gear cleaning before accessing any body of water. Information was also provided on vectors of introduction and propagation (such as releasing live bait, pet fish, and other aquatic organisms in the wild) on organisms that can be transported by boats and gear (fish, plants, eggs, larvae, parasites, and pathogens) and on the regulation controlling possession, transport, and exploitation of AIS. Threats represented by Asian carp, in general, are part of the information covered during the outreach. Even if no Asian carp species are present in Quebec's water, the great majority of anglers met during these activities were concerned about the possible propagation of Asian carp in the St. Lawrence River and in inland waters.

5.3.9 Ministry's Website

Information on AIS and their environmental and economic impacts, and instructions on how to prevent their introduction and propagation, can be found on the Ministry's website at http://www.mddep.gouv.qc.ca/faune/especes/envahissantes/index.htm. Specific information on Asian carp is also available at http://www.mddep.gouv.qc.ca/faune/especes/envahissantes/Carps-asiatiques.htm.

5.3.10 Regulations

Regulatory tools exist in Québec to control specific activities that can favor AIS introduction and propagation. These regulations involve the conservation and development of wildlife. The regulations are described below:

Aquaculture and the sale of fish regulation (Règlement sur l'aquaculture et la vente de poisson): Includes a list of prohibited freshwater fish and aquatic species. This regulation prohibits owning as a pet, keeping in captivity, transport, farming, breeding, stock, sale, or purchase of live specimen of listed species. The prohibited species are Asian carp (Black, Grass, Silver, Bighead, and Big-scale Silver), all the Channidae family (snakehead fish), non-indigenous eel and sturgeons, Blueback Herring, Eurasian Ruff, Round and Tubenose Gobies, Eurasian Perch, Zander, Tench, Wels Catfish, Common Rudd, Chinese Mitten Crab, and Rusty Crayfish. In addition, by this regulation, importation of baitfish is also prohibited in the province and there is no ban on the use of invertebrate as bait.

Regulation on baitfish (Règlement sur les poissons appâts): This regulation concerns sport-fishing activities only. Since April 1 2013, the use of live baitfish is prohibited in the province during summer season. In 2017, the use of baitfish will no longer be permitted, dead or alive, during the summer season. The use of baitfish during winter does not fall under this regulation and is permitted in restricted zones only, including the St. Lawrence River.

5.3.11 Ministerial Asian Carp Scientific Task Force

Because Asian carp threaten the St. Lawrence River and its watershed, the Ministry established, in summer 2014, an Asian Carp Scientific Committee (ACSC). The ASCS priority is to develop an emergency plan on Asian carp that includes early detection, rapid response, eradication, control, and monitoring for the St. Lawrence River and its tributaries. The Asian carp emergency plan will help the authorities take advised decisions in regard to preventing and controlling the introduction and propagation of Asian carp in Quebec's waters. Furthermore, the ACSC will analyze the impacts of the presence of Asian carp on aquatic biodiversity and ecosystems. The ASCS will also assess the impact on economic activities such as fisheries and tourism, on the implications of hydrological connectivity on the propagation of Asian carp to inland waters, and on costs and feasibility of interventions. Collaboration between the ACSC and research facilities, universities, and other ministries and jurisdictions will also be encouraged and proposed.

5.3.12 Mutual Aid Agreement

Quebec signed, in November 2014, the Mutual Aid Agreement proposed during the 2013 Governors and Premiers Summit held on Mackinaw Island. The Mutual Aid Agreement was endorsed, May 5, 2015.

6.0 Control Actions within the Upper Mississippi and Ohio River Basins

In 2014, the WRRDA was signed into law, authorizing a broad array of agency actions and public projects across the United States. Under WRRDA, the USFWS is directed to take actions, in collaboration with the USACE, National Park Service, and USGS, to prevent the further spread of Asian carp in the Upper Mississippi River Basin (UMRB) and the Ohio River Basin (ORB) (Figure 12). These actions include provision of technical assistance, interagency coordination, best practices, and support to state and local governments engaged in activities to decrease and eventually eliminate the threat. Congress acknowledged the success of the ACRCC's collaborative and strategic approach to Asian carp prevention by specifically referencing the Framework as a model to inform similar basin-wide partnership efforts being developed in the UMRB and ORB. WRRDA also strongly supports leveraging and sharing emerging technologies and lessons learned within and between the basins where Asian carp prevention efforts are being conducted, including the Great Lakes (through the ACRCC), UMRB, and ORB. WRRDA also included a requirement that the USFWS provide an annual report to the U.S. Congress, summarizing strategies, expenditures, and progress in addressing the threat of Asian carp in the UMRB and ORB and their tributaries over a 2-year timeframe. The first-ever iteration of the report, completed in December 2014, covers the 2 years preceding enactment of the legislation (June 2012 through June 2014).

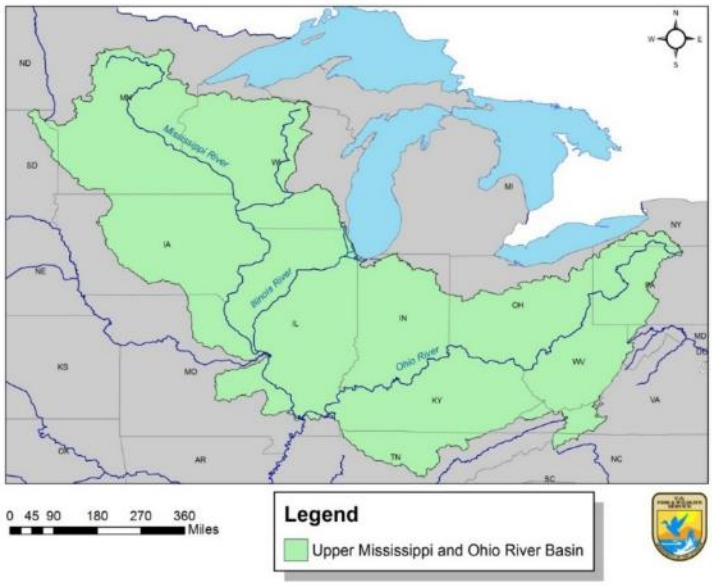


Figure 12. Upper Mississippi River Basin and Ohio River Basin (shaded green): geographic areas covered in the WRRDA Report.

To address the threat from Asian carp, UMRB and ORB resource management agency efforts now focus heavily on enhancing their ability to quickly detect the presence of Asian carp using state-of-the-art science and on developing the capacity to quickly and effectively implement subsequent actions to prevent further geographic spread, including containment of existing populations. State, federal, and non-governmental agency partnerships have been developing holistic strategies in both the UMRB and ORB to address Asian carp and other AIS, building, in part, on state AIS plans, as well as the Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States, and informed by the Framework and other existing strategies and mechanisms. For example, the Upper

Mississippi River Basin Association Task Force developed the Minnesota Asian Carp Action Plan to assess the threat posed by Asian carp and actions needed to minimize their impact in Minnesota, focusing on the Mississippi, St. Croix, and Minnesota rivers. Additionally, the USFWS is working with federal and state partners to draft an Action Plan for Management of Asian Carp in the Upper Mississippi River Basin.

The Ohio River Basin Asian Carp Control Strategy Framework was prepared by the Ohio River Fishery Management Team, which includes the States of Illinois, Indiana, Ohio, Pennsylvania, Kentucky, and West Virginia, which collaboratively manage fishery resources in the main stem Ohio River under the auspices of the Ohio River Fisheries Management Team (ORFMT). The Ohio River Basin Asian Carp Control Strategy Framework identifies tactics and projects by state and federal agencies necessary to prevent continued spread, reduce abundance of established populations, and minimize impacts of Asian carp populations in the ORB. The Framework includes specific recommendations for early detection, rapid response, prevention and deterrence, population control, and communication and coordination of ORB Asian carp populations.

Many of the control technologies and strategies currently under development to address the challenge of managing Asian carp populations in the IWW and the CAWS also hold promise for use in the ORB and UMRB. USGS is the primary federal agency spearheading research and development of new and emerging technologies in the United States, working closely with USFWS, USACE, and other state, federal, and non-governmental agency partners. Opportunities to apply the lessons learned from this research in the UMRB and the ORB are being identified and will be applied, wherever possible.

Currently, priority actions in the UMR and ORB focus on convening basin-specific partnerships to develop common strategies objectives and work plans); and to expand current efforts to ensure the highest level of coordination and collaboration moving forward, including:

- Development of ORB- and an UMRB-specific organizational and decision-making structures and related operating principles to facilitate interagency coordination, collaboration, and plan implementation on Asian carp prevention;
- Development of near-term and multi-year Asian carp prevention and control project plans utilizing collaborative decision-making to establish project priorities and identify available and required resources; and
- Development of a process to communicate at a policy level on Asian carp management issues across basins, and to harness collective capacity and expertise for additional synergy and benefits to all basin stakeholders.

USFWS is working closely with Mississippi Interstate Cooperative Resource Association (MICRA) to develop and implement each of these priority actions in the UMRB and ORB and will identify and leverage opportunities for future coordination with the ACRCC to collectively address the threat of Asian carp in the upper Midwest United States.

7.0 Grass Carp and Black Carp Control

Grass and Black Carp are being included in the Framework in FY 2015 for the first time. This section provides information on historical work by agencies as well as possible future efforts.

7.1 Grass Carp Control Efforts

In 2015, USGS will undertake efforts to develop control technologies for Grass Carp in coordination with state, federal, and university partners; these control technologies could be incorporated into IPM programs implemented by resource management agencies to control or manage Grass Carp in their jurisdictions. This project will build on past and current efforts associated with Bighead and Silver Carp and will focus on understanding the role of life history and behavior, hydrology, early detection, and control methods as part of an IPM approach. It will be built on a foundation of partner support from federal, provincial, state, and university research partners throughout the Great Lakes region and from several USGS centers with expertise to contribute to the research program.

With the recent discovery of Lake Erie Grass Carp reproduction, there has been increased interest in developing a strategic research plan that would include focusing on Grass Carp in the Great Lakes as well as other waters of the United States. USGS has documented that Grass Carp have spawned in the Sandusky River and that some of the young have survived. Six 1-year-old Grass Carp were captured in the Sandusky River in 2012, and USGS has determined that the six fish had no overlapping parentage, indicating a potentially large population of spawning fish. However, the extent of the Grass Carp population beyond these few fish is unknown. Understanding the extent of the invasion and whether Grass Carp are self-sustaining or growing is critical to understand where and how to address the issue of Grass Carp in the Great Lakes. USGS scientists have already begun to identify Grass Carp spawning habitat and investigate egg survival concurrently with Bighead and Silver studies. USGS efforts will take an IPM approach in the development and application of Grass Carp control technologies as needed and research a variety of complementary potential control mechanisms.

The presence of Grass Carp in the Great Lakes offers an opportunity to research the biology of Asian carp. As adults, Grass Carp differ in behavior and physiology from their relatives, the Bighead Carp and Silver Carp. However, they are similar to Bighead and Silver Carp in their spawning and early life history requirements. Grass Carp are often seen spawning together with Silver Carp, the eggs and larvae drift similarly and their young are often captured together in the same type of habitat. Where Grass Carp can successfully spawn and recruit, it is reasonable to suppose that Bighead Carp and Silver Carp also would be successful. Thus, a study of Grass Carp in the Great Lakes may inform future efforts with Bighead Carp and Silver Carp. What is learned in these studies of Grass Carp may be transferable in many cases to Bighead Carp and Silver Carp and useful in planning rapid response and control methods for those fishes should they access the Great Lakes. USGS has already begun some research efforts on Grass Carp, and these

activities are similar to efforts to understand and control Bighead Carp and Silver Carp. These efforts would have application to the Great Lakes region as well as other areas of the United States that are concerned with the potential spread of Asian carp. Furthermore, current research on the biology and control of Bighead Carp and Silver Carp may be useful in responding to Grass Carp invasions. Integration of research and control plans for all Asian carp may be advantageous.

The results of this research will provide a better understanding of which Great Lakes tributaries currently provide spawning conditions and contribute to the Great Lakes population of Grass Carp. This project will further promote an understanding of the extent to which continued escapement of diploid Grass Carp from aquaculture contributes to the population. This information will be useful for managers, who can use the information to decide where Grass Carp populations are established and whether additional deterrence of illegal movement of diploid Grass Carp is necessary. It will also measure age at maturation of grass carp in the Great Lakes, if sufficient numbers of fish are collected. Age at maturation has been shown to be a critical factor in assessing the risk that Bighead Carp will become problematic in the Great Lakes. An assessment of the Cuyahoga and Muskingum Rivers for spawning potential will also be completed.

Other Grass Carp efforts by the USGS in 2015 will include characterizing the feeding response to microparticles, documenting responses at the feeding stations, incorporating components to increase the efficacy of microparticle-delivered control agents, and evaluating the use of control agents incorporated into particles adhering to submerged aquatic vegetation or other delivery methods targeting Grass Carp. USGS will include Grass Carp in the algal attractant action item to evaluate their response to algal attractants and other food stimuli.

In an effort to prevent the illegal or unintentional release of grass carps into the Great Lakes, the USFWS requested the Mississippi Interstate Cooperative Resource Association (MICRA) to examine commercial Grass Carp production in the United States. The final report contains eight recommendations from MICRA on how to improve Grass Carp production, certification, shipping, stocking, and regulation. MICRA's report concludes that state Grass Carp regulations are varied and inconsistent, and a national policy strategy is needed to effectively minimize the risks of additional fertile and sterile Grass Carp introductions in the Great Lakes[17].

7.2 Black Carp Control Efforts

Currently, USFWS and USACE are developing eDNA markers for Black Carp. USACE began designing several sets of eDNA markers in February 2015 by obtaining whole mitochondrial DNA (mtDNA) sequence from as many as 30 individual Black Carp from several different areas to capture the breadth of intraspecific genetic diversity in the

[17] The use of grass carp (*Ctenopharyngondon idella*) in the United States: Production, triploid certification, shipping, regulation, and stocking recommendations for reducing spread throughout the United States. Report to the U.S. Fish and Wildlife Service from the Mississippi Interstate Cooperative Resource Association. February 2015. Agreement # F12AP00630. http://www.micrarivers.org/resource-materials/micra-documents/category/15-micra-reports.html

eDNA marker regions. Markers will be tested through an interagency validation study. Expected application of Black Carp eDNA markers could then be applied to a monitoring program, as early as spring 2016.

In October 2014, the Mississippi River Basin Panel's (MRBP) Research and Risk Assessment Committee recommended eDNA monitoring for Black Carp as a surveillance method in the Mississippi River Basin to the Aquatic Nuisance Species Task Force. The MRBP cited the potential for this species to have significant negative impacts on ecosystems of the Mississippi River. The MRBP recommended eDNA as a specific early detection tool focused on Black Carp because many variables, such as second-hand eDNA sources, that can confound the interpretation of eDNA detections would not apply to these particular species. Genetic early detection would assist managers by alerting them to the presence of these invasive species, thus allowing earlier response actions, regulations, or other management efforts to be implemented to minimize their spread and undesirable effects.

Specifically, the MRBP recommended that the Aquatic Nuisance Species Task Force support the USFWS's Midwest Region in development of real-time PCR markers for Black Carp and work with state partners to develop eDNA monitoring programs in specified areas. These efforts are modeled after the current program under way for Bighead and Silver Carp monitoring in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Early detection is essential for the ability to truly understand the movement and establishment into new areas.

In addition, the USFWS Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States[18] identifies overall goals that focus on prevention of introduction, control, containment of expansion of existing populations, and extirpation and minimizing adverse impacts of those populations. Providing knowledge to the public and conducting research to effectively manage and control all four species are also identified as primary goals of this USFWS control plan. Black carp were listed as injurious species under the Lacey Act in 2007, which prohibits the interstate transfer of the species, yet it is still used in aquaculture for snail control in some states.

The 2015 Framework includes many recently developed and ongoing control methods for Bighead and Silver Carp, and many of these control methods may also be applicable to Grass and Black Carp. However, targeted monitoring and surveillance plans are needed to accurately assess the risk of Black Carp in terms of invasion front and established populations. Increasing numbers of capture for the Black Carp in the Mississippi River and especially the Illinois River (Black Carp are currently only 300 miles from Lake Michigan) should signal the need for an increase in vigilance for this species. Additionally, not much is known about this species in North American waters, and misidentification of Black Carp based on its similarity in appearance to Grass Carp is

[18] Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C. 223 pp. http://www.anstaskforce.gov/Documents/Carps_Management_Plan.pdf

problematic. Education on proper identification of Black Carp for commercial fishers and law enforcement personnel is a priority.

8.0 THE ASIAN CARP REGIONAL COORDINATING COMMITTEE

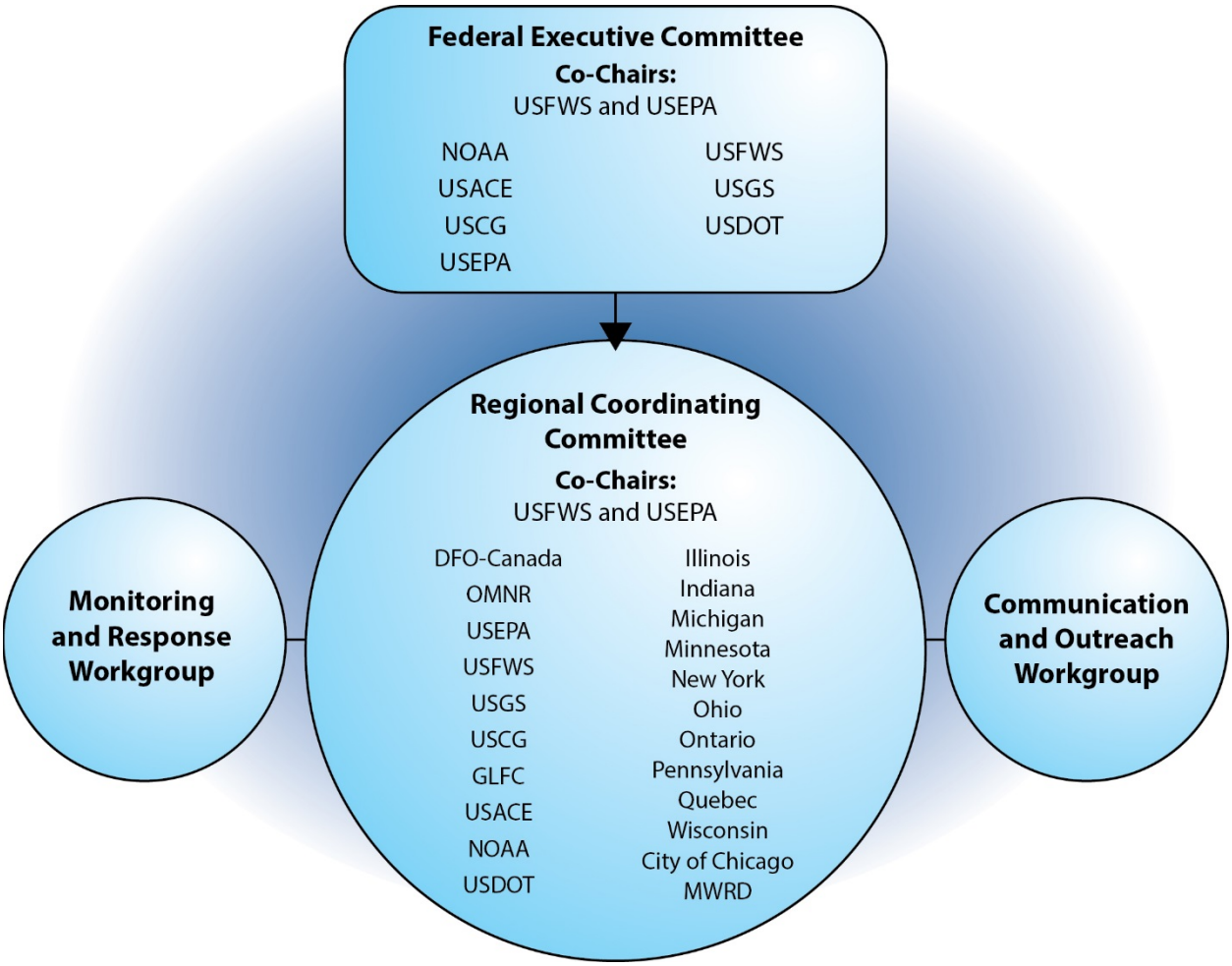
In 2009, federal, state, and local agencies formed the ACRCC to defend the Great Lakes against the introduction and establishment of Bighead and Silver Carp. The ACRCC has gone through a number of transitions in both composition and leadership since its original inception. The initial composition included affected federal agencies, the state of Illinois, Metropolitan Water Reclamation District of Greater Chicago (MWRD), and the City of Chicago. The ACRCC was chaired by representatives of USEPA, the state of Illinois, then White House Council on Environmental Quality (CEQ) to address the need for prevention measures in the CAWS. ACRCC membership was expanded to include the Great Lakes states and the Great Lakes Fishery Commission (GLFC) to better engage the United States' portion of the Great Lakes Basin. In 2012, the ACRCC again expanded to include the federal government of Canada (through DFO) and the provincial government of Ontario (through the OMNRF). In 2014, the provincial government of Quebec (Ministère de la Forêt, de la Faune et des Parcs) joined the ACRCC. In 2014, CEQ's role evolved to support and guide policy, strategy, budget, and agency coordination while representatives of USFWS and USEPA co-chaired the ACRCC.

The ACRCC organization chart is found in Figure 13. Information on the Jurisdiction, Authority, and Role of the other agencies that are members of the ACRCC can be found in the 2013 and 2014 Asian Carp Control Strategy Frameworks.

As co-chairs, USFWS ensures overall coordination, while USEPA uses its policy coordination authorities, plans for use of Great Lakes Restoration Initiative resources, and maintains responsibility for development of the annual Framework. The ACRCC represents a coordinated and collaborative effort among the involved organizations to prevent Bighead and Silver Carp from entering the Great Lakes.

The goal of the ACRCC is to execute an aggressive, multi-tiered strategy to prevent an Asian carp invasion into the Great Lakes and to ensure monitoring for necessary response actions. The ACRCC does not dictate management of fishery issues to individual states or provincial authorities and does not discourage or reject management principles, techniques, or actions. While the ACRCC does not directly implement activities, it develops the overall, coordinated strategy for control and management of Asian carp with input from each member and relies on each member agency to implement actions.

Figure 13. ACRCC Organization



8.1 Federal Executive Committee

The ACRCC Federal Executive Committee is charged with coordinating federal efforts in meeting the goals and objectives of the Framework and works collectively on any federal issues related to control, response, or federal policy and legal issues associated with the Asian carp efforts to prevent the establishment of Asian carp in the Great Lakes.

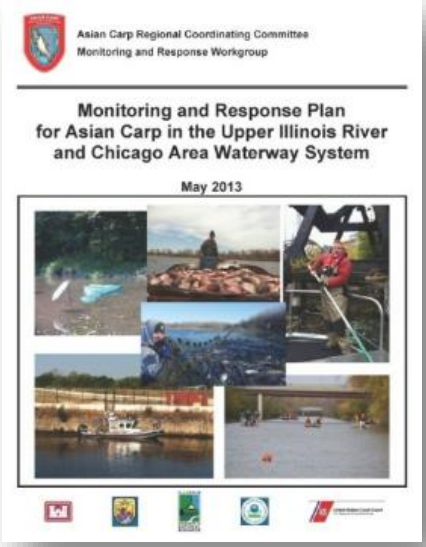
As co-chairs of the ACRCC, USFWS and USEPA lead the Federal Executive Committee. Other members include USACE, USCG, NOAA, the United States Department of Transportation (DOT), and USGS.

While coordination among federal, state, provincial, and local governments is essential to ensuring the most effective strategy and actions necessary to combat the spread of Asian carp, coordination among the federal agencies is equally important to ensure a coordinated, collaborative federal approach to the issue.

8.2 CAWS Monitoring and Response Workgroup

The MRWG of the ACRCC is tasked with monitoring and response efforts within the CAWS and at the leading edge of current Asian carp boundaries. This MRWG is generally composed of fisheries biologists and scientific experts from GLFC, Illinois DNR, Illinois Environmental Protection Agency, Indiana DNR, USFWS, and USACE. In 2012, all of the Great Lakes states fisheries chiefs were invited to participate in the MRWG. Since 2010, MRWG has created an annual Monitoring and Response Plan (MRP) for the CAWS and revises this plan annually with the overall goal of preventing Asian carp from establishing self-sustaining populations in the CAWS and subsequently in Lake Michigan. Five strategic objectives are specified in the plan to accomplish the overall goal:

- Determine the distribution and abundance of Asian carp in the CAWS and use this information to inform response removal actions,
- Remove Asian carp from the CAWS,
- Identify, assess, and react to any vulnerability in the electrical barrier system,
- Determine the leading edge of major Asian carp populations and reproductive success of those populations, and
- Improve understanding of the risk for the establishment of Asian carp in the Great Lakes.



The MRWG carries out these objectives through collective efforts by member agencies. The MRWG oversees eDNA collection within the CAWS, commercial fishing, netting, electrofishing, and other collection operations, and then interprets the data obtained to offer informed recommendations to the ACRCC.

8.3 Communications and Outreach Workgroup

The purpose of the Communications and Outreach Workgroup (CWG) is to facilitate internal and external communication on Asian carp prevention and control efforts of the ACRCC. The audiences include elected officials the public, key constituents, the media, ACRCC members, ACRCC Workgroup members, and other relevant groups outside the ACRCC.

Communication efforts support the ACRCC as it develops and executes short- and long-term strategies for preventing Asian carp movement as well as other monitoring and control activities in other areas of the Great Lakes Basin. CWG does not intend to supplant or supersede actions of the ACRCC members.

CWG has communication representatives from USFWS, EPA, USACE, USCG, USGS, the Great Lakes states, the province of Ontario, GLFC, and DFO-Canada.

CWG is currently co-chaired by USFWS and Illinois DNR. The co-chairs have primary responsibility for the group's management, organization, and operation**,** with the work activities shared among CWG members. One or both co-chair positions may be filled by a CWG member from another agencies as deemed appropriate by other CWG members.

Specific efforts of CWG include, but are not limited to, the following:

- Work in collaboration with ACRCC members to foster internal communications among ACRCC members
- Update and maintain the website at www.AsianCarp.us and other social media
- Distribute to appropriate agencies comments, concerns, and questions received from external audiences, including the public and key stakeholders
- Respond to media requests
- Provide video and photographic materials to members of the media, the ACRCC, and the public
- Coordinate on-site or telephonic media events, including press announcements, regarding new Asian carp control efforts and new detections of Asian carp
- Coordinate public forums and meetings
- Provide outreach to municipal leaders, tribal leaders, and other interested parties
- Serve in advisory capacity to the ACRCC regarding communication needs for the ACRCC's efforts
- Develop other outreach products for public use.

An important communication tool of the ACRCC that was recently developed is the Asian Carp toolkit. The toolkit can be found at www.AsianCarp.us. The toolkit is an on-line resource to provide basic information to resource managers on the development of:

- Control technologies, including seismic technology (waterguns), attractants, fish toxicants, and deterrents
- Assessment and response technologies
- Contract commercial fishing
- Monitoring and response actions, including eDNA sampling, analysis, and calibration; telemetry, acoustic and side scan sonar
- Barrier technologies, including the CAWS electrical barrier system, bubble-acoustic barrier, development at Eagle Marsh, the Des Plaines River bypass barrier, and the closure assessments at Little Killbuck Creek and Ohio Erie Canal

- Waterway traffic management and safety risk assessment
- Communication efforts.

The toolkit contains resources designed to assist in the efforts to control, plan, and communicate actions in the Great Lakes and across the United States and Canada, where necessary. The toolkit is intended to be simple and, to the extent possible, uses links to agency websites where additional information on the tool is available. The toolkit is directed to fisheries resource managers and identifies where and when specific technologies would be appropriate for use. The toolkit will be a living document, with current information added as it becomes available.

8.4 Stakeholder Participation

Stakeholder participation is essential to the continued success of efforts to control the spread of Asian carp and prevent their establishment throughout the Great Lakes Basin. The ACRCC considers stakeholder participation and engagement key components in the strategy for control. The ACRCC will continue to promote strong participation and stakeholder interest in the Framework by industry, environmental organizations, tribes/First Nations, Legislators, and the public through public meetings, and interagency collaborative efforts.

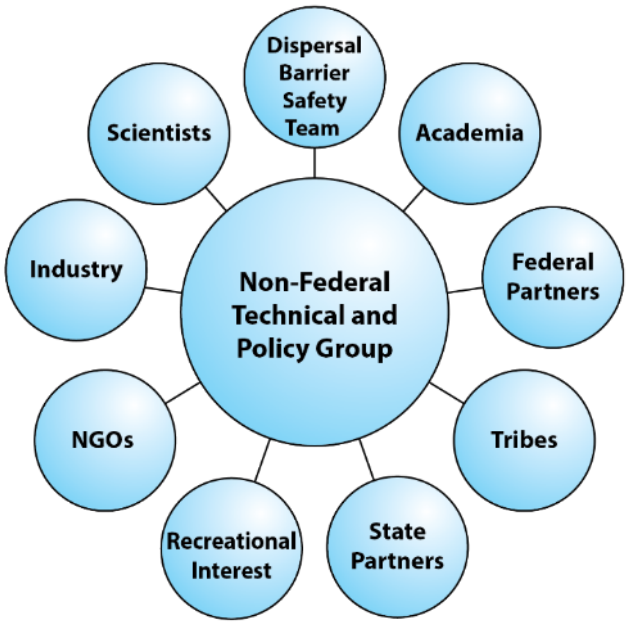
8.4.1 Technical and Policy Work Group

The Technical and Policy Work Group is a non-federal, entity that is composed of members from stakeholder organizations, public-sector agencies, the scientific community, academia, and others. Figure 14 shows the diverse membership of the group. While the Technical and Policy Work Group is not part of the ACRCC organization, it consults with the ACRCC and other agencies on invasive species matters.

The Technical and Policy Work Group grew out of the Barrier Work Group that was brought together to discuss alternatives and issues regarding the original electrical barrier that was installed in 2002. The work group provided input into the design of the original barrier and worked on issues such as barrier alternatives, barrier impacts on the barge industry, safety surrounding the employment of electricity in the CAWS, and impacts on local residents, business, and governments.

The Technical and Policy Work Group calls on federal, state, and local agencies to identify the best ways to move forward with controlling AIS in the CAWS.

Figure 14. Technical and Policy Work Group



8.4.2 Brandon Road Work Group

During FY 2014, the ACRCC supported the formation of a Brandon Road Work Group to focus efforts on the Brandon Road Lock and Dam. This work group is made up of state and federal partners with jurisdictional authority or a vested interest in implementing Asian carp control actions in this targeted area. The work group was formed to consider the Brandon Road Lock and Dam and downstream approach channel as a location to halt the movement of Asian carp through new or existing technologies.

The Brandon Road Work Group will accomplish the following:

- Coordinate development of barriers and risk reduction measures to block Bighead and Silver Carp passage in the vicinity of Brandon Road,
- Develop an integrated pest management approach at the Brandon Road area,
- Facilitate fisheries management agencies' involvement in risk reduction approaches,
- Identify potential environmental concerns, permitting challenges, and registration, and
- Communicate and coordinate with the other interested agencies.

New technologies being considered include a refined electric barrier system with a specifically engineered channel to increase the efficiency of the electric field, waterguns to exclude fish from entry into the approach channel and locks, and carbon dioxide barriers in the approach channel to provide a redundant fish repellant to the new electric barrier that protects the lock from Asian carp entry. (See Section 4.2.1 above for additional information regarding the efforts at the Brandon Road location.)

As of the release of this Framework, the Brandon Road Work Group is made up of the following member agencies:

- Illinois DNR
- USACE
- USCG
- EPA
- USFWS
- USGS

8.4.3 CAWS Advisory Committee

The CAWS Advisory Committee represents 33 public and private stakeholders that benefit from and have the responsibility related to the waterway, as well as regional stakeholder groups representing commercial, recreational, and environmental interests. The goal of the Advisory Committee is to reach consensus on a set of recommendations to government officials on short- and long-term measures to prevent Asian carp and other AIS from moving between the Mississippi River and Great Lakes Basins through the CAWS.

The advisory committee meets regularly in person and through committee calls and webinars to identify short- and long-term solutions. The advisory committee has provided consensus recommendations to Congress on short-term measures for the Brandon Road Lock and Dam, which is an important site for demonstration of one-way measures to reduce the risk of upstream movement of AIS into both the CAWS and the Des Plaines River. These measures include design of a new engineered channel to be constructed in the approach to the Brandon Road Lock, deployment of control technologies in the approach channel and the Brandon Road lock structure, and research into options for reconfiguring the lock to control AIS.

In its deliberations on a long-term solution, the advisory committee is examining options that would prevent two-way movement of AIS in the CAWS, while also taking into account potential impacts throughout the waterway relative to maritime transportation, flooding, and water quality. The advisory committee is also considering the extent to which a long-term solution can create local benefits, and how to structure local and regional cost sharing.

The advisory committee is currently examining technical issues related to various long-term scenarios and is planning to develop a set of consensus recommendations by December 2015.

ACRCC

Appendix A

2015 Agency Funding Matrix

FY 2015 Project Funding*

	#	Title	GLRI Funding ($)	Agency Funding ($)
USACE	1	GLMRIS Actions at Brandon Road	2,640,500	$500,000
	2	Lab Experimentation and Modeling to Quantify Response to CO_2 in a Flowing Environment	$821,000	$0
	3	Operation and Maintenance of Barriers	$0	$11,800,000
	4	Barrier I Constuction	$0	$37,700,000
	5	Telemetry - Barrier Efficacy Evaluation	$0	$200,000
	7	Monitoring and Response Team Support	$55,000	$0
	39	Ohio Erie Canal Pathway Closure Assessment	$400,000	$0
		Subtotal	**$3,916,500**	**$50,200,000**
USFWS	6	Great Lakes Asian Carp Monitoring Program	$350,000	$1,097,088
	7	Monitoring and Response Team Support	$1,120,000	$300,000
	8	Barge Entrainment and Interaction Study	$320,000	$0
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage	$160,000	$0
	10	Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters	$100,000	$0
	11	Program Capacity for eDNA Sampling	$650,000	$400,000
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	$314,000	$900,000
	13	Illegal Transport of Injurious Wildlife Enforcement	$400,000	$0
	14	Asian Carp Website O & M	$50,000	$100,000
	15	Use of Novel Sampling Gear: Video Outreach	$10,000	$0
	16	Registration of Microparticle Technologies	$150,000	$0
	17	Studies to Support the Use of Carbon Dioxide Barrier for Deterrence and Lethal Control	$300,000	$0
	43	Program Support for Asian Carp Activities	$100,000	$0
		Subtotal	**$4,024,000**	**$2,797,088**
	18	Development of Grass Carp Control Technologies	$0	$325,000
	19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	$315,000	$625,000
	20	Characterization of Brandon Road Lock for Barrier Implementation	$537,500	$0
	21	Use of Seismic Technology to Divert and Eradicate Asian Carp	$300,000	$410,500
	22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	$370,000	$200,000
	23	Developing Targeted (Microparticle and Piscicide) Control Systems	$200,000	$600,000
	24	Chemical Attractant Investigations to Increase Harvest and Control	$204,000	$274,000
	25	Use of Acoustic Technology to Determine Behavior	$0	$144,000
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	$250,000	$790,000
	27	Integrated Pest Management Program	$1,159,000	$1,741,729

FY 2015 Project Funding*

	#	Title	GLRI Funding ($)	Agency Funding ($)
USGS	28	Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp	$150,000	$0
	29	Control Technologies at Starved Rock	$200,000	$0
	16	Registration of Microparticle Technologies	$100,000	$50,000
	17	Studies to Support the Use of Carbon Dioxide Barrier for Deterrence and Lethal Control	$150,000	$100,000
		Subtotal	**$3,935,500**	**$5,260,229**
USFWS-IL DNR	30	Enhance Monitoring through CAWS Pathway	$1,950,000	$0
	31	Illinois River Stock Assessment/ Management	$300,000	$0
	32	Contract Fishing for Detection and Removal	$1,200,000	$0
	33	Interim and Long-Term Strategy and Tactics Development at Starved Rock	$100,000	$0
	34	Interim and Long-Term Strategy and Tactics Development at Brandon Road	$0	$0
	35	Use of Improved Gear and Novel Designs at Brandon Road	$150,000	$0
	36	Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System	$24,000	$0
	37	Community Initiatives to Increase Awareness, Surveillance and Enforcement	$300,000	$0
	43	Program Support for Asian Carp Activities	$100,000	$0
		Subtotal	**$4,124,000**	**$0**
USFWS-ODNR	38	Killbuck Creek Pathway Closure Assessment	$0	$0
	39	Ohio Erie Canal Pathway Closure Assessment	$0	$0
		Subtotal	**$0**	**$0**
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control	$0	$1,600
	41	Brandon Road Lock and Dam Risk Assessment	$0	$2,000
	42	Electic Barrier Contruction and Operation Risk Assessment	$0	$2,000
		Subtotal	**$0**	**$5,600**
2015 Totals			**$16,000,000**	**$58,262,917**

* Note that this Framework is not a commitment to future funding and that all out-year actions are subject to the availability of future appropriations and allocation decisions.

ACRCC

Appendix B

2015 Agency Action Items

2015 Framework – Agency Action Items

Table of Contents

1. GLMRIS Actions at Brandon Road

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$500,000	$2,640,500	$0

Project Explanation: Work under this template includes the study of ANS control technologies, as outlined by the GLMRIS, that could be implemented in the vicinity of Brandon Road Lock and Dam located in Joliet, Illinois. Further evaluation of ANS control measures at this control point constitutes a logical next step based on the range of alternatives identified in the GLMRIS report and input from stakeholders and the public during the public comment period for the report.

The output of this study effort will consist of a recommended plan set forth in a decision document. The decision document will evaluate options and technologies suitable for implementation in the vicinity of the Brandon Road Lock and Dam control point that will address movement of ANS from the Mississippi River Basin into the Great Lakes through the CAWS. Three species of concern are identified in the GLMRIS report that are anticipated to pose a high or medium risk to the Great Lakes. The decision document will include sufficient planning, engineering, and design to support an agency decision toward authorization for construction of a water resources project. The completed document would include required environmental compliance analysis and support the justification of an agency decision.

Summary of Actions to Date: USACE completed and released the GLMRIS report in January 2014. The GLMRIS report identifies eight potential alternatives – ranging from continuing current efforts to complete separation of the watersheds – and evaluates the potential for these alternatives to control the inter-basin spread of 13 ANS of concern, including Asian carp. These ANS of concern are composed of fish, algae, virus, crustaceans, and plants in all life stages with high or medium risk of adverse impacts caused by their transfer through the CAWS and establishment in the newly invaded basin.

Based on the evaluations presented in the GLMRIS report and in response to stakeholder input, USACE is conducting a formal evaluation of control technologies that could potentially be applied in the vicinity of the Brandon Road Lock and Dam. A public comment period on the proposed GLMRIS-Brandon Road effort closed on January 31, 2015. USACE hosted three public meetings as part of the scoping process.

FY 2015 Actions: Update information pertaining to ANS control measures that target swimming species and are the subject of continuing research and development during summer 2015. Screen ANS controls measures for each of species movement type: swimmers, floaters, and hitchhikers. Formulate alternatives with the measures and develop an expert elicitation process that will be used to assess the effectiveness of each of the alternative.

1. GLMRIS Actions at Brandon Road

FY 2016 Actions: Convene the expert elicitation panel and evaluate the navigation, environmental, and life safety impacts of each alternative. Develop parametric cost estimates for each alternative and anticipated operation and maintenance requirements. Evaluate each alternative based on risk reduction, cost, and impacts to waterway users and uses. Select an alternative and initiate a NEPA public review and internal and external expert reviews of the study documents. Begin to update study documents based on information gathered from reviews.

Expected Milestones:

June 2015 Alternatives Milestone

Outcomes/Outputs:

- Evaluate potential control technologies at Brandon Road Lock and Dam to reduce the risk of upstream interbasin transfer of ANS while minimizing impacts to waterway uses and users, and develop a recommendation.

Potential Hurdles: None

2. Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment

Lead Agency: USACE-ERDC

Agency Collaboration: University of Illinois Urbana-Champaign, USGS, IL DNR

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$821,000	$0

Project Explanation: This project includes research related to the efficacy, implementation, and impacts of the use of carbon dioxide gas (CO_2) as a non-physical barrier chemical to deter the movement of Asian carp within natural flowing water systems. Adding CO_2 to water has two main effects: (1) a reduction in pH caused by the formation of carbonic acid (a weak acid), and (2) elevation of dissolved CO_2 (hypercarbia). While the exact mechanism that induces avoidance for fish after CO_2 exposure has not yet been defined, it is believed that CO_2 functions by "irritating" the gills of aquatic organisms. It is important to note that additions of CO_2 do not function as a "bubble curtain" (not a physical obstruction), CO_2 does not deter movement by causing hypoxia, and the inevitable change in pH associated with elevated CO_2 is not sufficient to cause fish to move. Rather, it is believed that fish have CO_2 receptors in their gills and are able to sense CO_2 in the water, and it is the presence of a concentration of CO_2 that is physiologically unacceptable, causing intolerable gill irritation, that likely induces avoidance as fish seek water containing near normal concentrations of CO_2. Additionally, CO_2 does not appear to be species specific, with all fishes impacted in a similar fashion; a CO_2 barrier would therefore likely prevent the movements of non-target fishes as well. In addition, CO_2 appears to impact smaller fishes as well as larger ones. Combined, this information suggests a strong propensity for elevated CO_2 environments to act as a non-physical barrier to deter the movement of fishes across a range of sizes.

A large-scale pond trial to assess behavioral response of Bighead Carp, Silver Carp, and non-target fishes (Bigmouth Buffalo, Channel Catfish, Paddlefish, and Yellow Perch) has been completed. Discussions with the EPA regarding regulatory framework for research applications of CO_2 in open water applications, including barrier operations, have been initiated. An injection system has been manufactured that will allow for a large-scale, open-water treatment of CO_2. Trials evaluating the response of native mussels to CO_2 have been initiated and will be completed early in FY 2015.

The overall goals of this project are to:

(1) Quantify behavior of CO_2 in a quiescent environment.
(2) Quantify behavior of a CO_2 *plume* in a flowing environment.
(3) Quantify behavior of *fishes* in a flowing environment when exposed to a CO_2 barrier.
(4) Quantify behavior of *fishes* acclimated to CO_2 when exposed to flowing ambient water.
(5) Long-term behavior of *fishes* to CO_2 plumes in a flowing environment.

2. Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment

FY 2015 Actions:

- Initiate the studies to assess fish behavior to CO_2 in flowing systems.
- Water quality/chemistry
    - Complete CO_2 barrier scenarios.
    - Develop hydraulic model for Brandon Road.
    - Develop CO_2 plume model.
    - Initiate and complete report on water quality and the effects of operation of a CO_2 barrier.

FY2014/15 Products

- Preliminary hydrodynamic and water quality model of Brandon Road.
- Completion of CO_2 movement studies in quiet water.

FY 2015/16 Actions:

- Complete behavior testing of fish in advective environments.
- Provide information on downstream impacts of carbon dioxide on receiving environment.
- Complete water quality CO_2 transport study.
- Initiate concrete effects study.
- Assist USGS in field deployment.

FY 2015/16 Products:

- Report on fish behavior in flowing environments.
- Final water quality model and report.
- Preliminary data on concrete effects.

FY 2016 Actions:

- Examination of CO_2 acclimated fish to freshwater plume.
- Long-term response of fishes to CO_2-infused, flowing water.
- Assist USGS with implementation issues, field deployment and coordination.

Outcomes/Outputs:

- Define extent and duration of a carbon dioxide plume in the receiving body of water.
- Define potential for concrete damage from carbon dioxide barrier operation at Brandon Road.
- Define likely outcomes of different barrier operation scenarios.
- Develop predicative relationships between carp movement in response to changing concentrations of carbon dioxide in a flowing environment.
- Support USGS and other agencies in development and deployment of an operational barrier if a decision is made to proceed with implementation.

3. Operation and Maintenance of Barriers

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$11,800,000	$0	$0

Project Explanation: USACE operates three different types of fish deterrent measures throughout the CAWS. Each is designed to prevent movement of Asian carp toward the Great Lakes in a different manner.

- The Bypass Barrier physically blocks known bypasses around the electric barriers from the Des Plaines River and the Illinois and Michigan Canal caused by flooding. The barriers in these locations are intended to stop juvenile and adult Asian carp.
- The Electric Barriers operate by creating a waterborne pulsed direct current electric field in the CSSC. Fish penetrating the electric field are exposed to electrical stimuli, which act as a deterrent. As fish swim into the field, they feel increasingly uncomfortable. When the sensation is too intense, the fish is either immobilized or is deterred from progressing further into the field. Three barriers (Demonstration, IIA, and IIB) are currently operated by USACE.
- Bar screens on sluice gates at Thomas J. O'Brien Lock and Dam were installed to impede entry of Asian carp to Lake Michigan. All potential impacts were considered to ensure public health and safety, and the purposes of these structures must be maintained as authorized by law.

Summary of Actions to Date: USACE has operated electric barriers in the CSSC since 2002. Over the years, several operational and procedural improvements have been implemented to improve the effectiveness and to continuously deliver an uninterrupted flow of electricity to the water to deter fish.

The Des Plaines River Bypass Barrier was erected in 2010. Portions of the barrier were damaged during the record flood of April 2013. Subsequently, the fence fabric was reinforced through placement of riprap at the base of the structure, and later through construction of a berm composed of overburden material from the McCook Reservoir.

FY 2015 Actions: Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the electric barriers.

FY 2016 Actions: Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the electric barriers.

3. Operation and Maintenance of Barriers

Expected Milestones:

Electric Barriers

May/June Annual Maintenance
Quarterly Other Maintenance

Outcomes/Outputs: By operating and maintaining the barriers, minimize the risk of Asian carp movement toward Lake Michigan through the CAWS.

Potential Hurdles: None

4. Barrier I Construction

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$37,700,000	$0	$0

Project Explanation: Congress authorized USACE to upgrade the demonstration barrier to a public facility in the WRDA of 2007. Once completed, the permanent barrier will be capable of running at voltage levels high enough to repel smaller fish, similar to Barriers IIA and IIB, thereby providing additional protection against upward movement of Asian carp within the CAWS.

Summary of Actions to Date: Site work was completed in 2014. Contracts were awarded for fabrication and placement of the in-water structures, acquisition of the new barrier's electrical equipment, and construction of the building to house the equipment.

FY 2015 Actions: Construction of the building to house the electrical building is scheduled to begin in FY 2015. Placement of the structures to deliver and control the spread of electricity in the canal is scheduled for completion.

FY 2016 Actions: Installation of the electrical equipment and mechanical components is scheduled for 2016.

Expected Milestones:

1st Quarter 2015 Complete installation of in-water structures

3rd Quarter 2015 Initiate building construction

1st Quarter 2016 Award equipment installation contract

Outcomes/Outputs: Once completed, Barrier I is expected to be capable of delivering power necessary to deter fish. The overall electric barrier system redundancy is expected to significantly reduce the potential for system outages.

Potential Hurdles: None

5. Telemetry – Barrier Efficacy Evaluation

Lead Agency: USACE

Agency Collaboration: USFWS, SIU, IL DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$200,000	$0	$0

Project Explanation: USACE has led the telemetry efforts in the Illinois Waterway (IWW) and CAWS since 2010 with a primary objective of assessing the efficacy of the barriers as identified in the ACRCC MRP. By surgically implanting transmitters into fish species (both Asian carp and surrogate species), empirical data have been collected to demonstrate the barriers are effective in preventing fish passage in the upstream direction. Efforts to assess the efficacy of Barriers IIA and IIB will continue, and an array at the site of the new permanent Barrier I will be added. Additionally, the project will also include procurement of depth sensor transmitters to provide further insight into barrier challenges by surrogate species as well as how tagged fishes react to passing barge traffic. Further refinement of the stationary receiver network is an ongoing activity within the project, which increases efficiency and coverage within the system. By combining the array established by USACE with the new arrays established by SIU and USFWS, data will be collected to monitor long-term movement of Asian carp in the entire IWW, including localized movements through lock structures and at the area of the population's leading edge. Future downstream activities will focus on inter-pool movement across the Brandon Road Lock and Dam and finer-scale movement detection of Asian carp within the Dresden Island Pool.

Summary of Actions to Date: Since 2010, USACE researchers have successfully established an acoustic network of receivers positioned at more than 30 strategic locations from the Upper IWW into the CAWS. A Vemco Positioning System (VPS) was also established around Barriers IIB and IIA that is capable of providing 2D fish movements in relation to the barrier fields. Transmitters have been surgically implanted into 371 fishes that were released throughout the system. Mobile tracking and receiver downloads have occurred monthly to ensure up-to-date data are provided to decision makers regarding the efficacy of the barrier system. Some of the interim studies of the project have been completed, which include small fish barrier efficacy and barge interaction trials. Interim summary reports of work completed have been prepared yearly and included within the Monitoring and Response Plan annual summary report.

FY 2015 Actions:

- Implant depth sensor tags into surrogate species at the barriers.
- Implant depth sensor tags into surrogate species within the Brandon Road Lock.
- Coordinate with SIUC, USGS, and USFWS on best ways to combine monitoring practices at the Brandon Road Lock to assess barrier technologies.
- Maintain levels of transmitter density per pool.
- Adjust and increase receiver locations as needed.

5. Telemetry – Barrier Efficacy Evaluation

- Bi-monthly downloads and mobile tracking throughout the season.
- Coordinate data collection and record keeping with SIUC and USFWS.

FY 2016 Actions:

- Establish Barrier I VPS with most efficient receiver network available.
- Maintain levels of transmitter density per pool.
- Adjust and increase receiver locations as needed.
- Bi-monthly downloads with monthly mobile tracking during late spring and early summer.
- Coordinate data collection and record keeping with SIUC and USFWS.

Expected Milestones:

FY 2015:

- November 2014: Surgically implant an additional 50 fishes to maintain the current level of transmitter density within each pool of the study area.
- January 2015: Prepare and submit the annual report of findings to the MRWG.
- April 2015: Adjust acoustic receiver network as necessary to account for changes in Asian carp distributions.
- May 2015: Surgically implant 10 fishes with depth sensor tags and release at barriers and an additional 10 fishes with depth sensor tags and release in Brandon Road Lock in conjunction with USFWS sonar study.
- June 2015: Surgically implant an additional 50 fishes to maintain the current level of transmitter density within each pool of the study area.
- September 2015: Surgically implant 10 fishes with depth sensor tags and release at barriers.

FY 2016:

- January 2016: Prepare and submit the annual report of findings to the MRWG.
- April 2016: Adjust acoustic receiver network as necessary to account for changes in Asian carp distributions.
- May 2016: Acquire additional receivers and associated equipment to extend VPS system over permanent Barrier I.
- June 2016: Surgically implant an additional 100 fishes to maintain current level of transmitter density within each pool of the study area.

- September 2016: Install VPS around Barrier I and connect it with the existing VPS surrounding Barrier II.

Outcomes/Outputs:

Goal 1: *Determine if fish are able to approach and penetrate the Barrier (Barrier Efficacy)*

Objectives

- Monitor the movements of tagged fish (large and small) in the vicinity of the barrier using receivers placed immediately upstream, within, and immediately downstream of the barrier, in addition to mobile tracking.
- Implant surrogate fishes near the barriers with depth sensor transmitters.
- Analyze behavior and movement patterns of fish near the barriers as they interact with barge traffic.

Goal 2: *Determine if and how Asian carp pass through navigation locks in the Upper IWW*

Objectives

- Monitor the movements of tagged fish at Dresden Island, Brandon Road, and Lockport Locks and Dams using stationary receivers placed above and below each dam and within the lock chamber.
- Determine if there is adequate detection coverage to effectively assess fish passage through lock structures or other bypass pathways.

Goal 3: *Determine the leading edge of the Asian carp population and habitat use*

Objectives

- Determine if the leading edge of Asian carp invasion; currently, RM 281.5 is the upstream location of Asian carp population.
- Describe habitat use and movement in the areas of the Upper IWW and tributaries where Asian carp have been captured and relay information to the population reduction program undertaken by Illinois DNR and commercial fishermen.

Objectives of interagency and academia coordination:

- Integrate information between related acoustic telemetry studies.
- Download, analyze, and post telemetry data for information sharing.
- Expand and increase existing acoustic network in Dresden Island and Kankakee River while maintaining the capability to rapidly deploy to areas of interest in response to new information.

Potential Hurdles:

- Receiver deployment, retrieval, and protection within the electrified water of the barriers could present a challenge in the future.
- Floating debris and canal industry traffic could dislocate or damage submerged equipment, which would require mitigation. These types of problems have occurred in previous years but have been remedied by the team on a case-by-case basis.

6. Great Lakes Asian Carp Monitoring Program

Lead Agency: USFWS

Agency Collaboration: Great Lakes States, USGS, USACE, Academic Institutions

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$1,097,088	$350,000	$0

Project Explanation: USFWS will continue development, implementation, and refinement of a comprehensive and complementary early detection and rapid assessment surveillance program for Bighead Silver, Grass, and Black Carp in and near the Great Lakes. This program would complement the eDNA sampling and monitoring programs implemented by the USFWS, USACE, academia, and other partners. Sampling would primarily target areas of high concern in the Great Lakes (such as southern Lake Michigan, western Lake Erie, and areas with past positive eDNA results) and use a diverse array of traditional and novel gears to sample all potential life stages.

Summary of Actions to Date: The USFWS continues to work with partners to refine and implement a Great Lakes basin-wide early detection protocol for Asian carps and other AIS. USFWS continues to coordinate with federal, state, and provincial partners to annually identify sampling locations (areas of concern), further develop and refine protocols, share information, and discuss ways to coordinate agency sampling efforts.

In 2013, USFWS worked with its partners to conduct coordinated and complementary sampling efforts in the Great Lakes basin with both emerging technologies and traditional gears. From May to November 2013, USFWS collected 2,240 eDNA water samples, electrofished, and set nets to assess the presence or absence of Asian carp. In 2013, no Asian carp were captured, but positive eDNA results were obtained from USFWS sampling in three locations.

In 2014, USFWS expanded its overall Great Lakes sampling efforts and collected more than 4,200 eDNA water samples, electrofished, fyke netted, trawled, sampled ichthyoplankton with a variety of gears, and set other nets (bongo nets) and traps (light traps, minnow traps, and windmere traps) to survey for adult, juvenile, and larval Asian carps and other aquatic invasive fishes. In Lake Superior, 87 electrofishing runs, 75 fyke net surveys, and 45 trawl surveys were completed across four sampling locations, and no new non-indigenous species were detected. In Lake Michigan, 90 electrofishing runs, 55 fyke net surveys, 29 gill net surveys, 52 minnow trap sets, eight trawl surveys, five windmere trap sets, 119 bongo net tows, and 145 light trap sets were completed across five sampling locations, and no new AIS species were confirmed. In Lake Huron and western Lake Erie, 86 bongo net tows, 31 light trap sets, 60 fyke net surveys, 43 electrofishing runs, 45 trawl surveys, and 15 minnow trap sets were completed across four sampling locations, and no new AIS species were observed. In eastern Lake Erie, 36 ichthyoplankton and 67 juvenile/adult fish surveys were completed across two sampling locations, and in Lake Ontario, 47 ichthyoplankton and 76 juvenile/adult fish surveys were

completed across two sampling locations. In 2014, no Asian carp were captured, but positive eDNA results were obtained from USFWS sampling in two locations outside the CAWS (Kalamazoo River, Fox River—Lake Michigan).

FY 2015 Actions: USFWS will work with its partners to continue developing and refining standard sampling protocols for the Great Lakes and will continue implementing the protocol. USFWS staff and teams will be prepared, and may be mobilized, to respond to any Asian carp detected (using either traditional gear or eDNA) in the Great Lakes. USFWS and partner agencies will fully implement a comprehensive Great Lakes basin-wide early detection and monitoring program for Asian carps and other AIS. Efforts will continue on an annual basis to detect new invasions of Asian carps.

FY 2016 Actions: USFWS and its partner agencies will fully implement a comprehensive Great Lakes basin-wide early detection and monitoring program for Asian carp and other AIS. USFWS staff and teams will be prepared, and may be mobilized, to respond to any Asian carp detected (using either traditional gear or eDNA) in the Great Lakes. Efforts will continue on an annual basis to detect new invasions of Asian carps.

Expected Milestones:

- Fully implement a comprehensive and coordinated Great Lakes basin-wide early detection and monitoring program for Asian carp and other AIS species.
- Complete early detection surveys in suspected "hot spots" for AIS, in cooperation with partner agencies, as needed.
- Continue to refine SOPs for basinwide AIS monitoring with partner agencies.

Outcomes/Outputs:

- Ongoing early detection, rapid assessment, and rapid response program for the Great Lakes.
- Information that will build on existing knowledge of distribution and habitat requirements for Bighead, Silver, Grass, and Black Carp.

Potential Hurdles:

- Attainment of consensus regarding sampling gears and sampling design among diverse partners.
- Possible issues regarding sampling site logistics.
- Inefficiency of traditional sampling gear, particularly in large water bodies.

7. Monitoring and Response Team Support

Lead Agency: USFWS

Agency Collaboration: Illinois DNR, USACE

Funding Table:

Funding Year	Agency Funding			Asian Carp GLRI Funding			Other Funding
	USFWS	USACE	Total	USFWS	USACE	Total	
FY 2015	$300,000	$0	$300,000	$1,120,000	$55,000	$1,275,000	$0

Project Explanation: This task encompasses long-term monitoring and rapid response activities regarding Asian carp throughout the CAWS, both above and below the electric barrier system. Enhanced sampling with both conventional (electrofishing, netting, sidescan sonar, hydroacoustics, and rotenone) and novel gears (eDNA, DIDSON, and Paupier net) will be used to document Asian carp population dynamics within the canal system and connecting waterways, provide data for modeling potential population movements (range expansion), document fish behavior in and around the barriers, and determine life stages of Asian carp potentially present. Response activities may be implemented where specific evidence indicates the presence of Asian carp above the electric barriers, or if a catastrophic event necessitates immediate action.

Summary of Actions to Date: In 2013, Illinois DNR, USFWS, and USACE conducted extensive sampling efforts in search of Asian carp above and below the barriers after implementation of the ACRCC MRWG's updated 2013 MRP — which included additional and novel sampling gear types, a juvenile distribution study, additional telemetry and DIDSON evaluations, an evaluation of the impact of contract commercial fishing on Asian carp abundance, and a survey program of urban fishing ponds. Through June 2013, staff completed 400 electrofishing runs for a total of 100 hours. No Asian carp were observed through electrofishing. Service staff also conducted fish behavior studies (wild and caged) at the electric barriers. Service staff also participated in five responses, including Lake Calumet intensive surveillance, or barrier clearing exercises in 2013. In 2014, Illinois DNR, USFWS, and USACE again conducted extensive sampling efforts in search of Asian carp above and below the barriers after implementation of the ACRCC MRWG's updated 2014 MRP — which focused more efforts below the barriers and recommended evaluations at Brandon Road Lock. In 2014, four seasonal intensive monitoring events were completed in the CAWS. Staff completed 350 electrofishing runs and set more than 200 trammel/gill nets. No Asian carp were observed in 2014.

FY 2015 Actions: USFWS teams will support Asian carp monitoring and response activities throughout the region as necessary and help implement actions called for under the annually updated MRP.

FY 2016 Actions: USFWS teams will support Asian carp monitoring and response activities throughout the region as necessary and help implement actions called for under the annually updated MRP.

7. Monitoring and Response Team Support

Expected Milestones:

- Annual updating, approval, and implementation of the MRP.
- Attainment of goals and objectives set by the MRP.
- Completion of necessary monitoring with conventional and novel gears to determine the distribution and abundance of Asian carp in the CAWS.
- Participation in response efforts, as needed.
- Participation in necessary barrier clearing.

Outcomes/Outputs:

- Continued development of ACRCC's MRP, as needed, to monitor the leading edge of the Asian carp expansion.
- Support of Incident Command System (ICS) response operations as needed.
- Provision of staff, equipment, supplies, and ICS team members as needed.

Potential Hurdles:

- Weather conditions.
- Possible negative impacts on commercial vessel traffic movement, recreational uses, and resident aquatic life (other than Asian carp) from activities associated with this template.
- Possible public resistance to continued monitoring and response efforts.

8. Barge Entrainment and Interaction Study

Lead Agency: USFWS

Agency Collaboration: USACE

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$320,000	$0

Project Explanation: This task encompasses follow-up investigations to laboratory work conducted by USACE and field work completed by USFWS in 2012 and 2013 which showed that live fish could be entrained across the electrical barriers in the CAWS by passing barges to varying degrees, depending on barge configuration. The proposed work also aims to address questions raised by the recently formed Government/Barge Workgroup regarding behavior of fish in barge void spaces and distances fish may be entrained.

Specific study objectives are to: (1) evaluate behavior of fish near and in the void spaces of barges as they traverse the electrical barriers; and (2) determine the length of time and distance fish may be entrained in areas and void spaces of barges. Studies of this nature have not been conducted before to the best of our knowledge. Therefore, it is unclear what methods (DIDSON, video camera, underwater camera, or other means) might be best suited for these studies. It is also unknown how turbulence from barge movements and water clarity may impact our abilities to monitor fish in and around barges with video equipment, so we will use several methods to attempt this work. To answer questions related to the possibility of wild fish (free swimming, non-tethered) entering areas around barges, nets will be designed and deployed in the void spaces between the barges while barges traverse the barriers. We will attempt to deploy DIDSON units or video cameras around barges. The images from the DIDSON or underwater cameras will be used to view and count wild fish in barge junctions over time and distance traveled. Additional data on temperature, flow, speed of the barges, location, electrical measurements, and distances traveled by the barges will also be collected and compared with the images collected. Surrogate live, untethered fish may also be collected and dropped into the areas to collect additional images of fish behavior under simulated entrainment conditions if warranted.

The majority of project costs are to pay for contracts with barge companies to provide barges, time, and crew as a platform to conduct this work (est. 4 weeks of field work X approx. $100,000/week). Costs of this project could be reduced if barge operators were willing to provide barge platforms as an in-kind contribution.

Summary of Actions to Date: In 2013, USACE completed a laboratory-based model study using a scaled-down flume version of the CAWS barrier system and model fish and barges at its ERDC laboratory. This study showed that model fish assumed to be incapacitated by the barriers could be entrained beyond the barriers in void spaces between the barges. Further USACE studies of electric field strength around barges traversing the barriers showed distortion of the electric field and weakening of the electric field in some cases, particularly in the void space of a rake-to-box

barge configuration. Field studies conducted by USFWS in 2012 and 2013 used tethered and wild surrogate fishes to test if barges would entrain these fish and propel them through the barrier system. Two general methods were used, one where fish were placed directly in the spaces around barges as they traversed the barrier, and another where fish were placed across the canal in front of northbound barges crossing the barrier. These studies (http://www.fws.gov/midwest/fisheries/carterville/didson-barge.html) found that live fish were entrained across the barriers by passing barges to varying degrees, depending on the barge configuration. Field work scheduled for 2014 was delayed by late receipt of framework funding and subsequent contracting logistics, but will be completed in 2015.

FY 2015 Actions: A USFWS team will conduct studies of fish behavior in and around barges traversing the CAWS electrical barriers as described above in an attempt to: (1) evaluate behavior of fish near and in the void spaces of barges as they traverse the electrical barriers; and (2) determine the length of time and distance fish may be entrained in areas and void spaces of barges.

FY 2016 Actions: A USFWS team will conduct additional studies as needed. It is assumed that work completed in 2014 may generate more questions from agencies or the barge industry, similar to the manner in which work completed in past years generated additional questions from the Government/Barge Workgroup.

Expected Milestones:

- Data allowing agencies to determine the relative frequency of wild fish entering void spaces of barge tows.
- Data allowing agencies to determine the relative time spent and distance traveled by fish in void spaces of barge tows.
- Written project reports describing project results.

Outcomes/Outputs:

- Enhanced knowledge of behavior of fishes near barges and in void spaces of barge tows that could influence future operations in a manner that minimizes fish entrainment.
- Support of Government/Barge Workgroup.
- Satisfaction of USFWS partners in addressing potential entrainment issues at the barriers.

Potential Hurdles:

- Weather conditions.
- Turbulence and water clarity in and around barges may obscure systems used to monitor fish behavior.
- Possible issues regarding sampling site logistics.
- Potential difficulties in contracting or scheduling participation with barge operators.
- Potential conflicts with barrier maintenance activities.

9. Hydro-Acoustic Assessment of Lock Mediated Fish Passage

Lead Agency: USFWS

Agency Collaboration: USACE

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$160,000	$0

Project Explanation: There is great concern about upstream dispersal of Asian carp within the upper IWW and the effects of dispersal on the ecosystems of the Great Lakes. The Brandon Road Lock may presently act, or provide opportunity to be modified, as a barrier to fish movement within the upper IWW. Preliminary results of USFWS hydro-acoustic surveys within the Brandon Road and Dresden Island pools suggest that fish density is greater below the Brandon Road Lock in the Dresden Island Pool than above the lock. Asian carp are known to inhabit the Dresden Island pool.

Here, we propose to extend and enhance our collective understanding of fish passage dynamics at the Brandon Road Lock by making fine scale, real-time observations of fish passage within the lock, examining variables that affect fish passage such as commercial shipping and abiotic variables, and relating our observations to new understanding on lock-mediated upstream dispersal by Asian carp. Specific study objectives are to: (1) quantify the amount of upstream fish passage that occurs between the Dresden Island and Brandon Road pools via the Brandon Road lock; (2) assess fish behavior within the Brandon Road lock before, during, and after lockage operations; (3) compare fish passage at Brandon Road with Lockport Lock and Dam; (4) Determine if interactions between fish and commercial barge traffic, on entry or exit from the Brandon Road lock, are a significant factor in fish passage dynamics; and (5) understand lock-mediated upstream dispersal dynamics of Asian carp by examining fish passage at a downstream lock and dam where Asian carp are in high abundance.

The objectives of this project will be attained by use of several methods: (1) mobile and stationary split beam hydro-acoustic assessments of fish abundance, location, and passage rates within and near the Brandon Road lock structure will be conducted under a variety of operational conditions in an attempt to determine the number and size frequency distribution of fish that are making upstream passage via the lock; (2) DIDSON acoustic cameras will be deployed within the lock chamber at different operational conditions to assess the movement and behavior patterns of fish within the lock chamber; (3) a comparison of fish passage rates will be made between Brandon Road and Lockport lock using the above methods; and (4) an Asian carp lock-mediated dispersal behavior study utilizing all of the above techniques will be performed at Starved Rock Lock and Dam, a lock on the Illinois River where abundances of Asian carp are high.

Summary of Actions to Date: Efforts are currently under way by partner agencies (IL DNR, SIU, USGS, and USACE) to understand different aspects of fish passage at Brandon Road lock by utilizing complimentary techniques. SIU is undertaking sonar and telemetry work on both a river-

wide and a fine scale basis to understand and predict current and potential habitat use by Asian carp and other fishes. USGS is testing novel fish passage deterrent mechanisms. IL DNR has initiated intensive mark recapture studies to generate an understanding of cumulative fish passage by several species. USFWS has work currently under way that is explaining diel and seasonal patterns of fish abundance and behavior in Lockport, Brandon Road, and Dresden Island pools.

FY 2015 Actions: USFWS will conduct studies of fish behavior in and around the Brandon Road lock by deploying a split beam hydro-acoustic-equipped research vessel and stationary hydroacoustic fish detection system into and above and below the lock to survey fish abundance and size distribution during lock operation. Work will be attempted throughout the year. Preliminary trials of DIDSON deployment will be attempted to better understand the most appropriate methods for deployment within the lock chamber. Asian carp behavior will be examined at a downstream lock using split beam hydro-acoustic and DIDSON techniques.

FY 2016 Actions: USFWS will conduct additional studies as needed. It is assumed that work completed in 2015 may generate more questions from the Brandon Road work group or the barge industry.

Expected Milestones:

- Data allowing the Brandon Road work group and other collaborating agencies to determine the relative frequency and size structure of wild fish attaining passage from the Dresden Island pool upstream through the Brandon Road lock structure.
- Data allowing agencies to determine the fine scale spatial movement patterns of wild fish within and near the lock structure.
- Data that informs agencies and industry partners about potential fish passage vulnerabilities associated with commercial traffic.
- Data that describes lock mediated dispersal behavior of Asian carp.
- Written project reports and peer reviewed publications describing project results.

Outcomes/Outputs:

- Enhanced knowledge of behavior of fishes near the Brandon Road lock and fish interactions with barge tows that could influence future operations in a manner that minimizes fish passage.
- Enhanced knowledge of lock mediated dispersal behavior of Asian carp.
- Collaboration with partner agencies (USGS, IL DNR) to enhance value of individual research projects.

Potential Hurdles:

- Commercial traffic through the lock structure.
- Weather.
- Turbulence and air bubbles in and around the lock may obscure systems used to monitor fish behavior.
- Possible issues regarding sampling site logistics.

10. Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters

Lead Agency: USFWS

Agency Collaboration: USACE

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$100,000	$0

Project Explanation: Resource agencies and stakeholders are greatly concerned about the upstream dispersal of Asian carps within the Upper IWW and the potential effects on native ecosystems in the event of their introduction into the Great Lakes. The Electric Dispersal Barrier system located in the CSSC serves as a primary barrier to fish movement between basins. A demonstration barrier was operational between April 2002 and July 2014 and operated at 1.0 V/in., 5 Hz, 4 ms. Two newer barriers, Barrier IIA and Barrier IIB, were brought on line in 2009 and 2011. The newer barriers cover a much larger area than the Demonstration Barrier and are capable of generating electrical fields of much higher intensity. Initially, Barrier IIA had the same operating parameters as the Demonstration Barrier (1.0 V/in.). However, the operating parameters of Barrier IIA were increased to 2.0 V/in., 15Hz, 6.5 ms in August 2009 as a result of a pilot laboratory study conducted on Silver Carp ranging in size from 5.4-11.0 inches TL (Holliman 2011). Holliman (2011) found that at those parameters, 100 percent of those Silver Carp specimens were incapacitated. Barrier IIB began operation in April 2011 at 2.0 V/in. Barrier IIB operated at 2.0 V/in until 11/29/2011, when parameters for both barriers were increased to 2.3 V/in., 30 Hz, 2.5 ms. The increase to 2.3 V/in. was in response to intensive laboratory trials conducted on Bighead Carp that were 1.8-3.2 inches TL (Holliman 2011). Holliman (2011) found that those parameters incapacitated 100 percent of small Bighead Carp that were exposed to gradual increases in voltage in a Brett swim tunnel. Those parameters were also about 90 percent effective at preventing fish from swimming through a simulated barrier that small Bighead Carp were allowed to challenge.

Recently, due to unprecedented environmental conditions and resultant safety issues, the barriers have been operating at parameters that may be less than optimal for all size ranges of Asian carp at all temperatures (1.0 V/in, 34 Hz, 2.3 ms). To assess the potential for increased risk of fish challenging the barriers under sub-optimal operating parameters and under varying environmental scenarios, more robust and consistent monitoring and experimental testing are warranted. These data will inform refinement of management response plans and any subsequently necessary response actions, especially if these operational parameters will persist or be considered for use again in the future.

USFWS proposes to enhance our collective understanding of fish passage risk, under lowered operating parameters, with empirical evidence provided by field based studies. Data requirements for high confidence in risk level assessments include: (1) characterization of fish incapacitation responses to the electrical field produced by the barriers, under ambient

environmental conditions; (2) real-time quantification of relative fish abundance below the barriers; and (3) direct observational evidence of barrier efficacy. Abiotic variables, including water temperature, velocity, conductivity, and any other parameters that could affect fish behavior and susceptibility to electric current from the barriers will also be quantified. Experimental, field-based trials, conducted under ambient conditions, using surrogate fish of a range of sizes will be used to determine incapacitation responses to lowered operating parameters. This experiment will identify size classes of fish that may pose the greatest risk.

Fish behavior and abundance patterns will also be quantified under ambient environmental and electrical conditions by utilizing fixed or mobile split beam and multi-beam (DIDSON) hydroacoustic surveys. These techniques will allow real-time assessments of fish abundance and behavior in areas immediately below and within the barrier system.

Specific study objectives are to: (1) assess the responses of fish to the electrical field produced under the ambient conditions associated with reduced electrical intensity parameters at the barriers; (2) quantify fish abundance at the barriers in conjunction with changes in barrier operating parameters or environmental conditions on a fine spatial and temporal scale; and (3) assess fish behavior at the barriers in conjunction with changes in barrier operating parameters or environmental conditions. This work will be conducted in collaboration with USACE and the MRWG. Results from these evaluations will further inform other potential dispersal barrier projects utilizing in-water electrical current as a deterrent to fish movement.

The objectives of this project may be attained by use of several methods: (1) surrogate fish species electrical response experiments at the barriers under ambient field conditions; (2) mobile and stationary split beam hydro-acoustic assessments; (3) mobile and stationary multi-beam acoustic camera (DIDSON) surveys; and (4) trawling and or netting to confirm species composition of fish detected through remote sensing in areas below the barriers.

Summary of Actions to Date: From June 2011 to August 2013, USFWS completed evaluations of wild fish populations within the barrier system. Those evaluations showed multiple occurrences of wild fish (50-100 mm, likely Clupeids) appearing to cross the highest voltage areas of the barriers, always in schools. During those trials, the barriers were being operated at 2.1 V/in. and 2.3 V/in. We have not previously collected empirical survey data on fish behavior near the barriers with operational parameters set to 1.0 V/in. In March 2015, USFWS completed weekly hydroacoustic scans of the areas immediately below the barrier system (within 500 m of the barriers) in response to changes in barrier operating parameters to 1.0 V/in, 34 Hz, 2.3 ms. Relatively few fish were observed.

FY 2015 Actions: USFWS will conduct seasonal, real-time, field observations of fish behavior and abundance in and near the barrier system, while examining abiotic variables like water temperature, velocity, and conductivity that may affect fish behavior and susceptibility to electric current in the water from the barriers. Work will be attempted throughout the year, particularly in times of anticipated changes to barrier operating parameters.

10. Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters

FY 2016 Actions: USFWS will conduct additional studies as needed. It is assumed that work completed in 2015 may generate more questions from the MRWG work group or other partners.

Expected Milestones:

- Data allowing the MRWG and other collaborating agencies to determine the relative risk and necessary response actions of operating the barriers at less than optimal parameters due to changes in environmental or safety conditions.
- Data allowing agencies to better determine the seasonal abundance and behavior of fishes in and near the barriers to inform future decisions regarding changes in barrier operating parameters.
- Written project reports and peer reviewed publications describing project results.

Outcomes/Outputs:

- Enhanced knowledge of behavior of fishes near the electric dispersal barriers and fish interactions with the barrier system that could influence future barrier operations in a manner that minimizes the potential risk of fish passage.
- Collaboration with partner agencies (USACE, USGS, and IL DNR) to enhance value of individual research projects.

Potential Hurdles:

- Commercial traffic through the barriers.
- Weather.
- Increases in water current or conductivity.
- Possible issues regarding sampling site logistics.

11. Program Capacity for eDNA Sampling

Lead Agency: USFWS

Agency Collaboration: Great Lakes States, USACE

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$400,000	$650,000	$0

Project Explanation: USFWS Great Lakes Fish and Wildlife Conservation Offices are uniquely poised to collect samples from around the Great Lakes basin to be analyzed for Asian carp eDNA at the Midwest Fisheries Center, Whitney Genetics Laboratory. In FY 2013, the Service began to implement a comprehensive, effective, and efficient program in the Great Lakes to detect incipient invasions. This task will provide USFWS Fish and Wildlife Conservation Office facilities with resources and expertise to conduct integrated, long-term early detection activities in areas outside of the CAWS using eDNA. Funding received under this action item will support water sample collection around the entire Great Lakes Basin, and samples will be analyzed for eDNA at the Midwest Fisheries Center, Whitney Genetics Laboratory.

Summary of Actions to Date: USFWS continues to work with its partners to refine a Great Lakes basin-wide early detection protocol for Asian carp, and potentially other AIS species, using eDNA. USFWS continues to coordinate with federal, state, and provincial partners to annually identify sampling locations (areas of concern), share information, and discuss ways to coordinate eDNA sampling efforts within affected jurisdictions. In 2013 and 2014, USFWS worked with our partners to conduct coordinated and complementary sampling efforts in the Great Lakes basin with both emerging and traditional gears. From May to November 2013, USFWS collected 2,240 eDNA water samples. Positive eDNA results were obtained from USFWS sampling in three locations. In 2014, USFWS expanded its overall sampling efforts and collected more than 4,000 eDNA water samples from all five Great Lakes. In 2014, positive eDNA results were obtained from USFWS sampling in three Great Lakes locations.

FY 2015 Actions: The Service, in cooperation with our partners, will continue to monitor for the presence of Asian carp eDNA in the Great Lakes basin utilizing a statistically tenable sampling protocol. The Service will continue to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge.

FY 2016 Actions: The Service, in cooperation with our partners, will continue to monitor for the presence of Asian carp eDNA in the Great Lakes basin utilizing a statistically tenable sampling protocol. The Service will continue to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge.

Expected Milestones:

- Continued development of capacity for implementing an eDNA sampling program at USFWS Great Lakes Fish and Wildlife Conservation Offices.

11. Program Capacity for eDNA Sampling

- Continued implementation and refinement of an eDNA sampling protocol for other areas of concern, with particular focus on southern Lake Michigan and other potential hot spots for Asian carp invasions.

Outcomes/Outputs:

- Continued eDNA sampling in areas of concern by USFWS Great Lakes Fish and Wildlife Conservation Offices, conducted in close coordination with partners.
- Continued updating of the QAPP to include any necessary updates for collecting, handling, and processing water samples.

Potential Hurdles:

- Possible issues with eDNA calibration outcomes/output.
- Limitations due to weather and difficulties accessing sites.
- Maintaining QA/QC process regarding sample contamination in the field.

12. Fisheries Capacity for eDNA Processing and Technology Refinement

Lead Agency: USFWS

Agency Collaboration: USACE, USGS, Great Lakes States

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$900,000	$314, 000	$0

Project Explanation: This project will partially fund processing of eDNA samples for Asian carps at the USFWS Midwest Fisheries Center, Whitney Genetics Laboratory. Use of eDNA as a monitoring tool for Asian carp and other AIS is being improved through research efforts within federal agencies and academic institutions. To implement new techniques and methods as they are published, new methods and techniques must be tested and validated to be included in the QAPP and then implemented in official monitoring programs. Adaptations from the methods must be researched and then validated in at least three different labs. Furthermore, as the Great Lakes monitoring program commences and additional monitoring sites are added, the laboratory will be required to increase capacity and efficiency. Higher throughput can be realized with modifications to current procedures and methods, all of which require testing and validation in three laboratories to be adopted into the QAPP.

Summary of Actions to Date: The USFWS Whitney Genetics Laboratory was constructed and staffed in 2012, and newly hired staff engaged USACE to transfer processing operations from ERDC to USFWS. A transition plan from USACE to the USFWS was implemented, and the USFWS assumed a lead role for processing eDNA samples from the CAWS and from additional invasional hot spots in the Great Lakes basin. Working with partners, Service staff reviewed and updated the eDNA QAPP as necessary. In 2013, the Whitney Genetics Lab processed 2,240 eDNA water samples collected by Service offices. In 2014, the Whitney Genetics Laboratory processed more than 5,000 eDNA water samples collected by Service offices, and sampling will likely expand in 2015.

FY 2015 Actions: The Service will continue to process water samples collected by our Fish and Wildlife Conservation Offices, in collaboration with our partners, to detect the presence of Asian carp DNA in areas of concern. The Service will continue to evaluate and implement new collection and processing techniques for eDNA surveillance, to identify factors that may influence test results (detection capability of various sampling and processing techniques; environmental inhibitors) and to increase laboratory throughput.

FY 2016 Actions: The Service will continue to process water samples collected by our Fish and Wildlife Conservation Offices, in collaboration with our partners, to detect the presence of Asian carp DNA in areas of concern. The Service will continue to evaluate and implement new collection and processing techniques for eDNA surveillance, to identify factors that may influence test results (detection capability of various sampling and processing techniques; environmental inhibitors) and to increase laboratory throughput.

12. Fisheries Capacity for eDNA Processing and Technology Refinement

Expected Milestones:

- Continued processing of water samples for Asian carp eDNA sampling from areas of concern.
- Continued updating of the QAPP to include any necessary updates for collection, handling, and processing of water samples.
- Increased throughput of samples processed at the Whitney Genetics Laboratory due to procedural modifications, where possible.

Outcomes/Outputs: USFWS eDNA sample processing and analysis; providing results to state partners within 1 month of when samples were received at the Whitney Genetics Laboratory.

Potential Hurdles:

- Possible uncertainty in eDNA calibration outcomes.

13. Illegal Transport of Injurious Wildlife Enforcement

Lead Agency: USFWS

Agency Collaboration: Great Lakes States

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$400,000	$0

Project Explanation: Although transfer of AIS is currently illegal, stricter enforcement is necessary to mitigate the risk of transfer. Specific activities cannot be revealed, because disclosing those details will jeopardize law enforcement investigations under way. However, in FY 2015, the focus of this template will shift to equipping and training law enforcement personnel in the use of hand-held, genetic probes used to detect the presence of Asian carp in tanks of fish. These probes have been developed using past framework funding and should be available for testing and use in 2015. Funds may also be used to develop additional genetic markers for Black and Grass Carp as well, which can be used by law enforcement agents to interdict shipments of these fish.

Summary of Actions to Date: USFWS, Office of Law Enforcement expanded surveillance and enforcement of illegal transportation of federally listed invasive species. USFWS wildlife inspectors increased their efforts to target and interdict federally listed invasive species at border locations. In addition, USFWS has acquired a van that can be utilized to remotely scan containers and vehicles and that can be deployed at all international ports of entry. This van will allow USFWS wildlife inspectors to be more effective and efficient in their search for invasive species. In addition, the Office of Law Enforcement is working with state partners to control the spread of invasive species (including Asian carp) through investigations here in the United States. Specifics are considered law enforcement sensitive.

FY 2015 Actions: Investigative and inspection work will continue and expand, where necessary, in 2015 using all available tools. Specifics are considered law enforcement sensitive.

FY 2016 Actions: Investigative and inspection work will continue and expand, where necessary, using all available tools. Specifics are considered law enforcement sensitive.

Expected Milestones: None—specifics are considered law enforcement sensitive.

Outcomes/Outputs: Prosecutions of individuals involved in illegally importing or transporting federally listed injurious species in interstate commerce.

Potential Hurdles: None.

14. Asian Carp Website O&M

Lead Agency: USFWS

Agency Collaboration: Web content will be supplied by all members of the ACRCC

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$100,000	$50,000	$0

Project Explanation: The ability to provide information in a timely and accessible format is a critical component in the ACRCC's stakeholder participation efforts. The ongoing maintenance and continued expansion of www.AsianCarp.us as both a window into the ACRCC actions and source of trusted information on Asian carp requires extensive staff support.

Summary of Actions to Date: USFWS has built and managed www.AsianCarp.us since 2011. In 2014, www.AsianCarp.us continued to be the ACRCC's central platform for public outreach and education. As the site administrator, the Service maintained and developed the website, working toward increased visitation. Since www.AsianCarp.us launched in 2011, the site has reached more than 200,000 people. Website highlights from the last year include the addition of two educational videos; one on juvenile Asian carp identification (Michigan DNR) and the other on USGS's Asian carp control tools. The website was also expanded to include the Asian Carp Control Technology Toolkit, an on-line resource for managers to quickly learn more about ACRCC funded research related to control technologies, assessment technologies and communication efforts. With assistance from ACRCC Communication Work Group members, the Service also updated content throughout the website to ensure that it continues to be timely and accurate.

FY 2015 Actions: Recent research and subsequent media attention has placed new attention on Grass Carp, a species of Asian carp. A primary goal for the website in 2015 will be to enhance public understanding and awareness of grass carp issues. The website will also be expanded to reflect federal and state actions in the Upper Mississippi River and the Ohio River, as outlined in the WRRDA of 2014.

FY 2016 Actions: The website will be updated with current ACRCC documents and information. It will provide content that informs and educates the public on ACRCC actions and accomplishments.

14. Asian Carp Website O&M

Expected Milestones:

- The website will be enhanced with new information and outreach products in a routine and timely fashion from 2015 to 2016. It will take advantage of new and updated social media tools as appropriate.

Outcomes/Outputs:

- Fostering public understanding regarding the role of the ACRCC and the actions it undertakes.
- Identification of information gaps to better target outreach and communication activities.

Potential Hurdles: None.

15. Use of Novel Sampling Gear: Video Outreach

Lead Agency: USFWS

Agency Collaboration: NA

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$10,000	$0

Project Explanation: Brief educational videos available to the public on YouTube are an important outreach and communication tool. The proposed video project will focus on the Magna Carpa, the USFWS research vessel enhanced to support Asian carp assessment actions outlined in the framework. This vessel was designed to deploy multiple gears such as a Paupier net, an electrified Paupier net, and a Mamou trawl to more efficiently capture Asian carp species.

Summary of Actions to Date: Some footage and still images of these novel gears was already collected during previous filming trips for other projects. In 2014, video was collected to create an educational video that complements the newly released Asian Carp Toolkit. Video is currently in production at this time. In 2013, USFWS released the video, *Using eDNA in the Fight Against Asian Carp.* The year before, the Service released the video, *How to Identify an Asian Carp*. The videos continue to get public attention and to date have garnered more than 20,000 views.

FY 2015 Actions: In 2015, the video script would be developed, narration written and recorded, additional footage collected as needed, and the video editing completed. After the video is complete, the Service will launch it through social media, partner listservs, agency websites, and www.AsianCarp.us .

FY 2016 Actions: The video will continue to be a resource to the public and fisheries resource managers. It will therefore remain on www.AsianCarp.us and the Service's YouTube channel. It will be cross posted on websites and cited in press releases as appropriate.

Expected Milestones:

Spring 2015	Script is drafted and finalized
Spring/Summer 2015	Additional footage is collected during field season as
needed Summer 2015	Video editing begins
Fall/Winter	Video is completed

Outcomes/Outputs:

- Fostering public understanding regarding the role of the ACRCC and the Service in enhancing the tools and techniques used in assessment activities.
- A product that complements the proposed Asian Carp Toolkit, a resource for fisheries managers.

Potential Hurdles: None.

16. Registration of Microparticle Technologies

Lead Agency: USGS and USFWS

Agency Collaboration: IL DNR, USACE, SIU, University of Illinois Urbana-Champaign

Funding Table:

Funding Year	Agency Funding			Asian Carp GLRI Funding			Other Funding
	USGS	USFWS	Total	USGS	USFWS	Total	
2015	$50,000	$0	$50,000	$100,000	$150,000	$250,000	$0

Project Description: The goals of this project are to (1) provide regulatory affairs support for the registration of microparticle controls, and (2) develop registration-specific data to support the registration of microparticle controls for Asian carp. This project supports a larger project that is evaluating the development of microparticles to selectively deliver chemical and potentially biological control agents to Asian carp. Currently, antimycin-incorporated microparticles are being evaluated for the potential to control populations of Asian carp. This tool, however, must complete a rigorous registration process before it may be used within integrated pest management control programs of state and federal natural resource agencies. Results from this project will include the development of comprehensive SOPs and institutional guidance for use by approved state or federal agencies in implementing the chemical or biological control agents in prevention actions. The SOPs will be developed based on models of existing and approved protocols currently in use by resource management agencies in the United States (bi-national Sea Lamprey Control Program field protocols [currently in use in the Great Lakes basin], AFS Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management) and tailored to each specific microparticle control formulation. The chemical and biological control SOPs will serve as core components of the registration application documentation and will include protocols on safe transport, handling, storage, and dispersal of control agents and equipment; treatment site selection and management (including security and environmental monitoring); employee health and safety training and monitoring; and process for approval and compliance with all requisite federal, state and local environmental regulations (including Endangered Species Act Section 7 consultation, NEPA and Migratory Bird Treaty Act compliance, and other regulatory requirements).

The USGS Upper Midwest Environmental Sciences Center (UMESC) will provide regulatory affairs support to the USFWS in the development of biological and chemical pesticide controls of Asian carp. Regulatory affairs support will include compilation of data and reports for submittal to regulatory agencies (such as USEPA), identification of required data to attain chemical registration, coordination of experimental use permits, and other regulatory support as needed to attain and maintain chemical registrations of tools to control Asian carp. The UMESC will also develop specific data required to attain registration of microparticles to control Asian carp, including studies to describe product chemistry, physical/chemical properties and USEPA Group A acute toxicity (acute oral, dermal, and inhalation toxicity, eye and dermal irritation, and skin sensitization).

USFWS will partner with USGS to complete the USEPA registration processes required for new toxicants under the FIFRA and lead development of the multiple SOPs for implementation of the control techniques. USFWS will provide support in preparing any needed Section 7 consultations

to ensure that all actions taken regarding testing and implementation of Asian carp control technologies are compliant with the ESA. USFWS staff will provide site-specific consultations for potential field test sites and wider consultations as appropriate for planned control/chemical application areas, which could include multiple states and multiple USFWS regions. USFWS will prepare any necessary biological opinions, if consultation processes yield a finding of "likely to adversely affect" a listed species, and will work with USGS and partners to prepare any needed incidental take permits or exemptions, if required under the ESA. USFWS will work with USGS to compile the required health and safety information and complete procedural requirements needed for USEPA to evaluate proposed control techniques and ensure that they will not pose unreasonable risks of harm to human health and the environment. In addition, the USFWS will assist with developing use manuals and labeling requirements for control technologies developed under this template and liaise with USGS, USEPA, and other partners to fulfill other requirements of the USEPA registration process. The Service will serve as eventual registrant of Asian carp control technologies developed under this template and will work with USGS to ensure that any applications, including experimental or test applications, of control technologies developed under this template are compliant with NEPA.

Summary of Action to Date:

- During FY 14, UMESC participated in registration and control technology projects by initiating formulation review with the USFWS to determine Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles.
- During FY 14, USFWS initiated development of SOPs to provide guidance for field use of microparticle-based Asian carp control agents by approved agents and collaborated with USGS to identify and obtain target sensitive native fish and mussel species for laboratory testing to support the registration process.

FY 2015 Actions:

- Complete formulation review with USEPA to determine registration data requirements of antimycin-incorporated microparticles.
- Initiate submission of studies to complete USEPA registration of antimycin-incorporated microparticles to USEPA.
- Coordinate submittal of studies to address Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles.
- Assess registration requirements of alternative control agents of Asian carp.
- Provide regulatory affairs support for control products registered by the USFWS and other public agencies.
- USFWS will continue development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of microparticle controls.
- USFWS, in partnership with USGS, will develop and initiate safety and training programs and protocols for agency staff for implementation of control technologies in the field.
- USFWS will initiate acquisition of materials and equipment needed for field implementation of microparticles at select sites that are yet to be determined.
- USFWS will work with USGS to prepare and submit required documentation to serve as the agency registrant for the microparticles.

16. Registration of Microparticle Technologies

- USFWS will initiate Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at the Brandon Road Lock and Dam in the Illinois Waterways System, and other locations, if specified.

FY 2016 Actions:

- Complete review with USFWS to determine Section 7 ESA-consultation data requirements of antimycin incorporated microparticles in limited open-water application sites.
- Complete registration review with USEPA to determine registration data requirements of an antimycin incorporated microparticles in limited open-water application sites.
- Respond to USEPA and state regulatory agencies review of data submitted to register antimycin-incorporated microparticles.
- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of antimycin-incorporated microparticles.

Expected Milestones:

- Determination of USEPA registration and Section 7 ESA-consultation data requirements for antimycin-incorporated microparticle registration.
- Acquisition of Experimental Use Permits to allow experimental use of antimycin-incorporated microparticles in limited open-water application sites to control Asian carp.
- Registration of an antimycin-incorporated microparticle formulation.

17. Studies to Support the Use of Carbon Dioxide Barrier for Deterrence and Lethal Control

Lead Agency: USGS and USFWS

Agency Collaboration: IL DNR, USACE, SIU, University of Illinois Urbana-Champaign, University of Minnesota-Duluth

Funding Table:

Funding Year	Agency Funding			Asian Carp GLRI Funding			Other Funding
	USGS	USFWS	Total	USGS	USFWS	Total	
FY 2015	$100,000	$0	$100,000	$150,000	$300,000	$450,000	$0

Project Description: This project will support the use of CO_2 to control Asian carp. CO_2 is being evaluated as both a barrier to minimize expansion of Asian carp and as a lethal control tool in specific situations. As a barrier, CO_2 must be evaluated for its environmental impacts on species of concern to help meet the requirements of the Endangered Species Act (section 7 consultation). CO_2 as a lethal control tool must undergo a rigorous registration process before it may be used within integrated pest management control programs of federal or state natural resource agencies. The goals of this work will be to (1) provide regulatory affairs support for the use of CO_2 as a barrier to control Asian carp and (2) develop registration-specific data to support the registration of CO_2 as a lethal pesticide control. This project supports a larger project that is evaluating CO_2 to control Asian carp. This project includes the development of comprehensive SOPs and institutional guidance for use by approved State and Federal agencies when implementing the chemical or biological control agents in prevention actions. The SOPs will be developed based on models of existing and approved protocols currently in use by resource management agencies in the United States (e.g. bi-national Sea Lamprey Control Program field protocols (currently in use in the Great Lakes basin), AFS Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management). The chemical and biological control SOPs will serve as core components of the documentation required to use CO_2 as either a barrier or a lethal control agent, and will include protocols on safe transport, handling, storage, and dispersal of CO_2 and equipment; treatment site selection and management (including security and environmental monitoring); employee health and safety training and monitoring; and process for approval and compliance with all requisite Federal, State and local environmental regulations (including ESA Section 7 consultation, NEPA and Migratory Bird Treaty Act compliance, and other regulatory requirements).

The USGS UMESC will provide regulatory affairs support to USFWS in the development of biological and chemical pesticide controls of Asian carp. Regulatory affairs support will include compilation of data and reports for submission to regulatory agencies (e.g. USEPA), identification of required data to attain chemical registration, coordination of experimental use permits and other regulatory support as needed to attain and maintain chemical registrations of tools to control Asian carp. The UMESC will also develop specific data required to attain registration of CO_2 to control Asian carp including studies to describe product chemistry, physical/chemical properties and USEPA Group A acute toxicity (acute oral, dermal, and inhalation toxicity, eye and dermal irritation, skin sensitization).

17. Studies to Support the Use of Carbon Dioxide Barrier for Deterrence and Lethal Control

USFWS will partner with USGS to complete the USEPA registration processes required for new toxicants under the FIFRA, and lead development of the multiple SOPs for implementation of the control techniques. The USFWS will provide support in preparing any needed Section 7 consultations to ensure that all actions taken regarding testing and implementation of Asian carp control technologies are compliant with the ESA. USFWS staff will provide site specific consultations for potential field test sites and wider consultations as appropriate for planned control/chemical application areas, which could include multiple states and multiple USFWS regions. USFWS will prepare any necessary biological opinions, if the consultation processes yields a finding of "likely to adversely affect" a listed species, and work with USGS and partners to prepare any needed incidental take permits or exemptions, if required under the ESA. USFWS will work with USGS to compile the required health and safety information and complete procedural requirements needed for USEPA to evaluate proposed control techniques and ensure that they will not pose unreasonable risks of harm to human health and the environment. In addition, USFWS will assist with developing use manuals and labeling requirements for control technologies developed under this template, and liaise with USGS, USEPA, and other partners to fulfill other requirements of the USEPA registration process. The Service will serve as eventual registrant of Asian carp control technologies developed under this template, and will work with USGS to ensure that any applications, including experimental or test applications, of control technologies developed under this template are compliant with NEPA.

Summary of Actions to Date:

- During FY 2014, UMESC completed waiver requests for specific sections of CFR 40 parts 150 to 159 for sections that most likely do not apply to anticipated use of CO_2 as a control agent.
- During FY 2014, USFWS initiated development of SOPs to provide guidance for field use of microparticle-based Asian carp control agents by approved agents, and collaborated with USGS to identify and obtain target sensitive native fish and mussel species for laboratory testing to support registration process.

FY 2015 Actions:

- Complete review with USFWS to determine Section 7 ESA-consultation data requirements of a CO_2 barrier or the use of CO_2 as a control agent in limited open-water application sites.
- Coordinate submission of studies to complete USEPA registration for the use of CO_2 as a control agent in limited open-water application sites.
- Coordinate submission of studies to address USFWS Section 7 ESA-consultation data requirements of a CO_2 barrier or the use of CO_2 as a control agent in limited open-water application sites.
- Provide guidance for studies on effects of CO_2 on non-target organisms to ensure compliance with Section 7 ESA-consultation.
- Provide regulatory affairs support for control products registered by the USFWS and other public agencies.
- USFWS will continue development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO_2 for control of Asian carp.

17. Studies to Support the Use of Carbon Dioxide Barrier for Deterrence and Lethal Control

- USFWS, in partnership with USGS, will develop and initiate safety and training programs and protocols for agency staff for implementation of control technologies in the field.
- USFWS will initiate acquisition of materials and equipment needed for field implementation of control technologies at select site(s), TBD.
- USFWS will initiate Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at the Brandon Road Lock and Dam in the IWW System, and other locations, if specified.

FY 2016 Actions:

- Respond to USEPA or state regulatory agencies regarding the use of CO_2 as a barrier or to register CO_2 as a control agent in limited open-water application sites.
- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of the use of CO_2 as a barrier or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp.
- Assist management agencies that plan to deploy CO_2 as a barrier or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

Expected Milestones:

- Determination of USEPA registration and Section 7-ESA consultation data requirements for use of CO_2 as a barrier or the use of a CO_2 as a control agent in limited open-water application sites to control Asian carp.
- Acquisition of Experimental Use Permits to allow experimental use of CO_2 as a barrier or as a control agent in limited open-water application sites to control Asian carp.
- Registration of CO_2 as a barrier or as a control agent in limited open-water application sites to control Asian carp.

18. Development of Grass Carp Control Techniques

Lead Agency: USGS-GLSC, CERC, IL WSC, UMESC

Agency Collaboration: OH DNR, Bowling Green State University, University of Toledo, Central Michigan University, Michigan State University, and Great Lakes Fishery Commission (potentially Ontario Ministry of Natural Resources and Department of Fisheries and Oceans Canada)

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$325,000	$0	$0

Project Description: With the recent discovery of successful reproduction of Grass Carp in Lake Erie, there has been increased interest in developing a strategic research plan that would include focusing on Grass Carp in the Great Lakes as well as other areas of the U.S. USGS has documented that Grass Carp have spawned in the Sandusky River and that some of the young have survived. Six 1-year-old Grass Carp were captured in the Sandusky River in 2012, and USGS has determined that the six fish had no overlapping parentage, indicating a potentially large population of spawning fish. However, the extent of the Grass Carp population beyond these few fish is unknown. Understanding the extent of the invasion and whether Grass Carp are self-sustaining or growing is critical in understanding where and how to address the issue of Grass Carp in the Great Lakes. USGS scientists have already begun to determine Grass Carp spawning habitat and investigate egg survival concurrently with Bighead Carp and Silver Carp studies. USGS will take an integrated pest management approach in addressing Grass Carp control, informed by adequate biological information as needed and researching a variety of complementary potential control mechanisms.

The presence of Grass Carp in the Great Lakes, while undesirable, does offer an opportunity to research the biology of Asian carp in the unique Great Lakes system. As adults, Grass Carp differ in behavior and physiology from their relatives, the Bighead Carp and Silver Carp. However, they are similar to Bighead Carp and Silver Carp in their spawning and early life history requirements. Grass Carp are often seen spawning together with Silver Carp, the eggs and larvae drift similarly, and their young are often captured together in the same type of habitat. Where Grass Carp can successfully spawn and recruit, it is reasonable to suppose that Bighead Carp and Silver Carp also would be successful. Thus, a study of Grass Carp in the Great Lakes may inform future efforts with Bighead Carp and Silver Carp. What is learned in these studies of Grass Carp may be transferable in many cases to Bighead Carp and Silver Carp and be useful in planning rapid response and control methods for those fishes should they access the Great Lakes. USGS has already begun some research efforts on Grass Carp, and these activities are not necessarily mutually exclusive of our efforts to understand and control Bighead Carp and Silver Carp. These efforts would have application to the Great Lakes Region as well as other areas of the United States that are concerned with the potential spread of Asian carp. Furthermore, current research on the biology and control of Bighead Carp and Silver Carp may be useful in responding to Grass Carp invasions. Integration of research and control plans for all Asian carp may be advantageous.

This project will build on past and current efforts associated with Asian carp and will focus on understanding the role of life history and behavior, hydrology, early detection, and control methods

as part of an Integrated Pest Management approach. It will be built on a foundation of partner support from federal, provincial, state, and university research partners from throughout the Great Lakes region and from several USGS centers with expertise to contribute to the research program.

FY 2014 Actions:

- Analyzed and disseminate research conducted in 2013 on Grass Carp early life history and developmental rate, sinking rate and size of eggs, survival and hatching of settled eggs, and behavior of larvae.
- Collected hydraulic and water-quality data on the Cuyahoga River, a Lake Erie tributary, and the Muskingum River, a tributary to the Ohio River. The Muskingum was added at the request of OH DNR owing to positive eDNA samples collected as far upstream as Zanesville, Ohio.
- Collected hydraulic and water-quality data on the Cuyahoga River, a Lake Erie tributary, and the Muskingum River, a tributary to the Ohio River. The Muskingum was added at the request of OH DNR owing to positive eDNA samples collected as far upstream as Zanesville, Ohio.
- Continued to receive Grass Carp collected by federal and state collaborators from the Great Lakes or other areas of North America where Grass Carp are not known to be established. Collected aging parts, genetic material (for studies of parentage and spawning populations), otoliths (for microchemistry determination of sources and locations where the fish have lived, or for oxygen isotope determination of temperatures), gut contents (to determine food consumed) and muscle plugs (for stable isotopes), gonad material (for determination of reproductive status and age at maturity) and eyes (for determination of ploidy and thus fertility). Samples will be archived until a sufficient number of fish are collected to proceed effectively with the different technologies. Samples were received from Lake Erie, Calumet Harbor area, and a few tributaries to the Ohio River. Otolith microchemical analysis of 2014 collected fish will be completed in fall 2014.
- Larval fish and egg sampling was conducted on the Sandusky River. Sampling began in Late May and continued through July. We sampled most high-flow events and several other intervening periods. Bongo nets were used in the main channel at three sites (near Fremont, Ohio, near the I-80 bridge, and several km downstream of the I-80 bridge, spanning about 10 river km. Light traps were used in backwater and periphery main channel areas in vegetated, wood-debris, and open water areas. No larval Grass Carp or eggs were sampled.
- Otolith cores from Grass Carp captured from the Lake Erie and Lake Michigan basins analyzed for oxygen isotopes. Otolith core $\delta 18O$ and $\delta 13C$ of triploid fish were consistent with isotopic signatures characteristic of aquaculture pond origin, as expected. Diploid fish captured in the Lake Erie basin had otolith core isotopic signatures reflective of Lake Erie tributaries, providing potential evidence of natural recruitment. In contrast, otolith core $\delta 18O$ and $\delta 13C$ of diploid Grass Carp collected from the Lake Michigan basin was consistent with that of fish produced in aquaculture. This method requires additional validation.

18. Development of Grass Carp Control Techniques

FY 2015 Actions:

- Update the FluEgg tributary assessment model to incorporate Grass Carp, to be used in predicting adequacy of rivers for Grass Carp reproduction and recruitment.
- Complete trace chemical (including isotopic information) analysis of otoliths of Grass Carp collected in the Great Lakes basin, to determine locations of Grass Carp recruitment within the basin.
- Process collected hydraulic and water-quality data (fall 2014).
- Update and run FluEgg model with data from additional tributaries (fall 2014).
- Hydrologic habitat assessment of the Grand River (Ohio) to model suitability for spawning of Grass Carp (spring 2015).
- Egg and larval drift collections in the Sandusky River and possibly Michigan tributaries to western Lake Erie.
- Continue to receive Grass Carp collected by state and federal collaborators and to collect the parts as described above.
- Age Grass Carp collected by state and federal collaborators and collect GSI and gonad histology to determine age of maturation in the Great Lakes basin.
- Validate otolith core oxygen isotope ratio method for identification of aquaculture fish through measurement of isotopes of triploid and diploid fish from aquaculturists that produce Grass Carp for stocking. Continue to perform otolith core measurements of oxygen isotopes of Grass Carp collected from the Great Lakes basin to establish extent of escapement of illegally-stocked diploid fish as a contribution to the Great Lakes Grass Carp population versus natural reproduction within the basin.
- Mine archived data on air temperatures, rainfall, wind vector and direction, and deploy thermal recorders at several locations in the Sandusky River to generate finer-scale models of flow-temperature relationships to refine assessment of spawning risk in the Sandusky River and potentially a Michigan Tributary to Lake Erie.
- Using Wabash River, Illinois River, Sandusky River, and Michigan tributary data, develop a greater understanding of the interrelationships among rainfall (snowpack?), discharge, air temperature, and water temperature on triggers for Asian carp spawning.
- Collaborate with OH DNR to collect and acoustically tag live Grass Carp in the Sandusky River to better understand movements and habitat use (potential).
- Identify potential control or management strategies that could be incorporated as part of an integrated pest management program developed by the responsible resource management agency.
- Initiate a study of Grass Carp bioenergetics in Lake Erie.
- Initiate a lake-wide inventory of aquatic vegetation, including species composition and relative abundance, distributions, presence of non-native species; and identification of areas with abundant vegetation.
- Write reports/publications and present a professional meetings.

FY 2016 Actions:

- Continue to collect otolith core oxygen isotope data and otolith transect microchemistry and isotopes on Grass Carp that are captured within the Great lakes basin.
- Create first-generation probabilistic (Bayesian) models of risk of spawning using on hydrologic and meteorologic variables.

18. Development of Grass Carp Control Techniques

- Third and final year of larval and egg sampling to assess spawning. Finalize protocols for sampling eggs/larvae and monitoring river and thermal conditions and transfer to state or USFWS.
- Continue identification of potential control strategies and implement bioenergetics work and vegetation mapping.
- Write reports/publications and present a professional meetings.

Expected Milestones:

February 2015	Otolith core oxygen isotope method validation completion.
2015-2016	Demonstrate spawning status of Grass Carp in the Sandusky River
September 2015	Complete spawning potential assessment of the Cuyahoga and Muskingum Rivers.
2015-2016	Identification of locations for deployment of control measures. Development of a bioenergetics model of Grass Carp in Lake Erie and simulations of potential effects at various population sizes.

Outcomes/Outputs:

- A better understanding of which Great Lakes tributaries currently provide spawning conditions and contribute to the Great Lakes population of Grass Carp, and an understanding of the extent to which continued escapement of diploid Grass Carp from aquaculture contributes to the population. This information will be useful for managers, who can use the information to determine where Grass Carp populations are established, and whether additional deterrence of illegal movement of diploid Grass Carp is necessary.
- Age at maturation of Grass Carp in the Great Lakes will be determined, if sufficient numbers of fish are collected. Age at maturation has been shown to be a critical factor in assessing the risk that Asian carp will become problematic in the Great Lakes.
- Completed assessment of the Cuyahoga River and Muskingum River for spawning potential (report/publication).
- Sandusky River (and Michigan tributaries), Wabash River, and Illinois River work will generate one or more publications on risk of successful spawning of Grass Carp.
- Development of a plan for potential control strategies in the Sandusky River.

Potential Hurdles:

- As of the deadline for submitting this template, we did not yet have a final decision as to whether Grass Carp collection would be permitted in the Sandusky River. If it is not, no tagging or tracking or biology work will be possible. A meeting including USGS, MI DNR, OH DNR, Michigan State University, Central Michigan University, and the GLFC is to be held in March or April to establish research partnerships and priorities for Grass Carp work in Lake Erie.

19. Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

Lead Agency: USGS

Agency Collaboration: IL DNR, USFWS, MWRD, SIU, USACE, University of Illinois, and Purdue

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$625,000	$315,000	$0

Project Description: The upstream movement of Asian carp through the Illinois River has been documented by IL DNR, USFWS, and USACE. These efforts have documented the distribution of the Asian carp population within the pools of the Illinois River and have identified habitats favorable for Asian carp. Since 2006, the upstream expansion of the carp population has stalled in the Marseilles and Dresden Island Pools. Sharp contrasts in habitat, flow conditions, water quality, and food supply between these pools and the CAWS may be acting as controlling factors to the stalled migration. A major objective of this project is to determine the controlling factor(s), with the possibility that one or more of these factors could be used to prevent future migration or to reduce Asian carp populations.

Several techniques will be used to characterize these potential controlling factors and data collection will be coordinated with the other agencies efforts to provide maximum complementary data collection and analysis. Flow, velocity and a suite of water-quality parameters (water temperature, pH, dissolved oxygen, specific conductance, chlorophyll-a, blue-green algae, nitrate, and turbidity) will be collected continuously in the main channel and backwater areas of the river. Plankton sampling data will be used to characterize the available food supply in this reach of the river. Along with the continuous monitoring, discrete samples will be collected to analyze for contaminants not previously analyzed such as hormones and pharmaceuticals. Existing data, including long-term water-quality sampling by the MWRD will be reviewed. In addition to a greater understanding of why Asian carp have not moved farther upstream, the velocity and flow data will be evaluated to determine optimum locations (channel constrictions, pinch points, and backwater areas) within the river that may be suitable for the testing of Asian carp control strategies. The applicability of this methodology will be evaluated for the downstream sections of the Illinois River. Day-to-day movement of Asian carp recorded from field observations and telemetered fish (IL DNR/USFWS/USACE/ SIU/IN DNR/Purdue University) will be analyzed with the flow and water-quality data to evaluate fish response to changing flow conditions.

While new control methods were being developed, important advances in the understanding of basic Asian carp life history were also being made. The combination of a better understanding of Asian carp life history and new control technologies can lead to the larger scale control efforts with hydrologic controls.

19. Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

Hydrologic controls utilize the acquired knowledge of Asian carp life history combined with manipulation of river hydrology to have a larger, river-wide impact on the Asian carp population. The IWW, with eight lock and dam structures and river levels maintained by USACE, contains waterway infrastructure suited to implementing hydrologic control methods. Examples of hydrologic control applications could be the isolation of backwater areas critical to juvenile Asian carp through river level manipulation using river control structures. This application of hydrologic control has the potential to disrupt recruitment for an entire year class of Asian carp. Another example using hydrologic control could be the application of food attractants and microparticle piscicides to draw adult fish into a backwater that has structural control over water levels. Once Asian carp are into the backwater, the structural control can prevent the fish from escaping back to the river as they are harvested. Hydrologic control methods, when combined with mechanical, chemical, and biological controls, have the potential for a larger, river-wide impact on entire year classes of Asian carp and thus present an opportunity to lower the risk of Asian carp reaching the Great Lakes through the IWW.

The physical and hydrologic characteristics of backwater areas along the IWW vary considerably. The channel bedslope gradient is much steeper in the upper IWW (above Starved Rock) than in the lower IWW. Mean channel velocity is generally higher in the upper waterway than in the lower waterway. Along the lower IWW (below Peoria), backwaters and sidechannels are more common than in the upper IWW. The physical connection of backwater areas to the main channel also varies. These hydrologic characteristics influence circulation within the backwater, water residence time, water quality and habitat. This project will use this information along with SIU's fish telemetry data to evaluate backwater areas used by Asian carp for implementation of hydrologic control methods. Hydrologic control methods, when combined with mechanical, chemical, and biological controls, have the potential for a larger, river-wide impact on entire year classes of Asian carp and thus present an opportunity to lower the risk of Asian carp reaching the Great Lakes through the IWW.

In addition to the Illinois River, other rivers, such as the Wabash River in Indiana, provide an opportunity to examine factors that influence Asian carp movement, spawning, and recruitment. These rivers represent the lower end of the size range thought to be used by Asian carp for spawning and would provide an ideal setting to test the tributary assessment tool (FluEgg) developed in a previous template project. FluEgg simulates egg transport and can help in determining reach length required for successful egg hatching. For successful recruitment, egg hatching needs to occur in close proximity to larval habitat, so FluEgg results will need to be linked with habitat data for a more complete picture of likely population growth in a river. Laboratory testing of eggs (or surrogates) will also be completed to verify the transport properties and further refinement of FluEgg. Once FluEgg has been verified with data from these experiments and spawning rivers, it can be more widely disseminated to states with Asian carp populations and Great Lakes states for planning purposes. The next evolution in tools for the partner agencies will be developed to include the evaluation of habitat for small fry as an addition to the tributary assessment tool.

19. Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

Summary of Action to Date:

- Hydraulic and water-quality data collection and analysis
  - Secured and deployed equipment for 2 real-time water-quality stations, one in the main channel of the Illinois River (Illinois River at Seneca), and one in a backwater (Hanson backwater at west culvert pits), and one streamflow only station (at the main entrance at the Hanson backwater), used to correlate movement of Asian carp population front relative to water-quality and other factors.
  - Collected site-specific data for demonstration activities in mid-August 2013 including bathymetric surveys, velocity mapping, and fluorometer deployments for dye monitoring of algal feeding attractants.
  - Completed initial water velocity and temperature surveys of the Marseilles and Dresden Island Pools of the Illinois River.
  - Coordinated water velocity and water temperature mapping of Upper Illinois River
  - Published 2013 WY water-quality data for Illinois River main channel and backwater sites.
  - Summarized water velocity and temperature mapping for the April 2013 documented spawning event in the Marseilles Pool and shared with IL DNR.
- Spawning and Recruitment (completed under template #2.5.11)
  - USGS Scientific Investigations Report, "Hydraulic and Water-Quality Data Collection for the Investigation of Great Lakes Tributaries for Asian carp. Spawning and Egg-Transport," by Murphy, E.A. and Jackson, P.R. published
  - "Development of a Fluvial Egg Drift Simulator to evaluate the transport and dispersion of Asian carp eggs in rivers," by Garcia, T., Jackson, P.R., Murphy, E.A., Valocchi, A.J., and Garcia, M.H. published in Ecological Modelling.
  - Hydraulic and water quality characterization on the Wabash River completed jointly with Purdue University egg collection.
  - "Aspects of embryonic and larval development in Bighead Carp."
  - *Hypophthalmichthys nobilis* and Silver Carp *Hypophthalmichthys molitrix*," by George, A.E. and Chapman, D.C. published in PLOS ONE
  - Grass Carp developmental series work completed.
  - Contributed to journal article on grass carp spawning in Sandusky River.
- Fish Telemetry
  - Collaborated with SIU and USGS South Dakota WSC on visualization of Asian carp telemetry data. (completed under template #2.5.25)
  - Installed real-time fish telemetry equipment at two sites on the Wabash River and an Eagle Marsh tributary in Indiana.
  - Maintained real-time fish telemetry equipment on Wabash River and transmitted data to USGS National Water Inventory System.
  - Began pilot on real-time data evaluation of Asian carp responses to water-quality and other changes in conjunction with researchers from SIU.
  - Established fish telemetry database for the existing Asian carp data modeled on the database for the Klamath River Basin-Washington.
- Spawning and Recruitment
  - Submitted journal article on FluEgg user interface and example application to

Great Lakes Research.
- Completed flume experiments using pseudo-eggs.
- Began a Wabash River spawning and transport characterization journal article in collaboration with Purdue University.
- Submit publication of egg size and buoyancy and for developmental rate and behavior of grass carp early life stages.
- Evaluate reservoir tributaries for presence of Asian carp eggs and larvae during the peak spawning season.

FY 2015 Actions:

- Hydraulic and Water-Quality data collection and analysis
  - Publish 2014 WY water quality data for Illinois River main channel and backwater sites.
  - Continue mapping of water velocity and water quality in Illinois River main channel and backwater.
    - Collect water velocity and water quality data during spawning event to help inform IL DNR and ILNHS sampling and for FluEgg simulation of Illinois River egg development and dispersal.
    - Collect water chemistry samples through study reach for detailed chemical analysis (including pharmaceuticals and hormones laboratory schedules) and evaluate for potential effects on Asian carp population. The results from this sampling will be used to contrast the water chemistry of areas where few Asian carp are present with that of areas with established Asian carp populations to determine if a gradient in chemical constituents explains the different population levels.
  - Evaluate controlling factors for Asian carp movement in the upper Illinois River.
- Spawning and Recruitment
  - Conduct drifting egg sampling and deploy additional environmental sensors (water temperature loggers) to build on models for improved understanding on reproductive ecology in the Wabash River (Purdue).
  - Begin efforts to incorporate successful recruitment criteria (juvenile habitat and other factors) with existing egg transport characterization methodologies to determine which rivers may pose a greater probability for the establishment of

sustainable populations including investigating the use of remote sensing for increased efficiency.
    - Continue support of FluEgg model maintenance and increased functionality (such as incorporation of native species data and required habitat).
    - Develop a mortality model to include in the FluEgg model.
    - Outreach to state and federal partners on how the FluEgg model can help them assess the risk of Asian carp spawning and recruitment in their rivers of concern.
    - Complete field trials for egg capture and coordinated characterization between the USGS, IL DNR, and ILNHS.
    - Collect and analyze data on juvenile migration farther upstream in the Illinois River.
- Fish Telemetry
    - Maintain real-time fish telemetry equipment on Wabash River locations until the barrier at Eagle Marsh is completed, establish telemetry equipment in upper Illinois River at Seneca, and publish the data collected. The site on the Illinois River complements the established network.
    - Continue collaboration with SIU and Purdue fish telemetry groups to manage, interpret, and present data. Engage with USFWS and states to integrate all available Asian carp location data into the developed database.
- GIS analysis
    - Inventory available map resources and LIDAR data in the IWW to identify potential backwater sites favored by juvenile Asian carp.
    - Evaluate potential backwater sites with input from SIU/IL DNR/USFWS biologists and hydrologists.
- Publication of journal article on FluEgg graphical user interface and example application.
- Grass Carp early life stages publication.

FY 2016 Actions:

- Hydraulic and water-quality data collection and analysis
    - Publish 2015 WY water quality data for Illinois River main channel and backwater sites.
    - Publish WQ analyses from FY15 sampling effort.
    - Publish results of IL River synoptic.
- Spawning and Recruitment
    - Continue drifting egg sampling in the Wabash River to inform potential efforts to control Asian carp at early life history stages (Purdue).
    - Continue to incorporate successful recruitment criteria (juvenile habitat and other factors) with existing egg transport characterization methodologies to determine which rivers may pose a greater probability for the establishment of sustainable populations
    - Outreach to state and federal partners on how the FluEgg model can help them assess the risk of Asian carp spawning and recruitment in their rivers of concern.
- Fish Telemetry
    - Maintain real-time fish telemetry equipment on upper Illinois River and publish the data collected.

19. Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

- Hydrologic and Water Quality Data Collection
    - Evaluate and consult with coordinated team of USGS, IL DNR, INHS, and other partners on potential backwater sites in the upper Illinois River.

Expected Milestones:

Summer 2015	Data collection on a critical river for analysis of Asian carp spawning and recruitment
February 2015	Presentation at Midwest Fish and Wildlife conference on FluEgg model simulation of May 2013 spawning event in Marseilles Pool of the Illinois River.

Outcomes/Outputs:

- Greater understanding of Asian carp preferred habitat with regards to hydraulic and water-quality characteristics and insight into how habitat may be altered to deter them from spreading into new areas.
- Incorporate successful recruitment criteria (juvenile habitat and other factors) with existing egg transport characterization methodologies to determine which rivers may pose a greater probability for the establishment of sustainable populations.
- Increase the robustness of the FluEgg egg transport and dispersal model and disseminate it to the states to assist in the identification of rivers that pose elevated risk for reproduction of Asian carp by using hydraulic characteristics to simulate egg travel times and likelihood of staying in suspension until hatching.
- Web-based tool for visualizing fish telemetry data with river hydraulic and water-quality data for analysis of Asian carp movement.
- USGS NWIS-Web display of real-time counts of tagged fish with respect to fixed monitoring stations to monitor Asian carp movement relative to barriers.

Potential Hurdles:

- The project has a large field data collection component that is subject to weather delays during the year.
- Publication schedule is affected by length of time various reviewers need which is beyond the control of project personnel.
- The project relies on obtaining fish telemetry data from collaborators outside the project.
- Potential impacts for native species dependent on backwater areas of the IWW.

20. Characterization of Brandon Road Lock for Barrier Implementation

Lead Agency: USGS

Agency Collaboration: USACE, USFWS, MWRD, IL DNR

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$537,500	$0

Project Explanation: To help prevent the movement of Asian carps from the Mississippi River basin to the Great Lakes basin, additional barriers to the CAWS have been proposed at Brandon Road as a component of the GLMRIS report developed by USACE in three of the eight alternative plans. The plans outlined by the USACE suggested implementation of a combination of new electric barriers and a "GLMRIS Lock" with an estimated timeline of 10 years or longer. Newer barrier technologies such as waterguns or carbon dioxide to drive fish away have been suggested as approaches that could be implemented relatively quickly.

To implement the use of these technologies at the Brandon Road location would require a better understanding of the impacts of lockages, structures, and other influences that could constrain the deployment of these technologies. The USACE is concerned about the potential impacts associated with the deployment of these technologies on or near these structures, such as waterguns on the canal walls and carbon dioxide on lock chambers. Furthermore, the deployment of these technologies could impact the movement of barges and other vessels.

The success of the project will depend on the collaboration with partners on potential barriers and the availability of existing data. This template is designed on the assumption that potential barriers and data gaps will be identified in the project meeting and that subsequent field characterization and other studies will not be necessary after the first efforts. If additional follow-up studies are necessary, expectations for future efforts will need to be revised.

Summary of Actions to Date (some completed under previous templates):

- Testing of CO_2 barriers in ponds has shown that fish move away from the barrier.
- Waterguns have been shown to drive away fish in pond studies and data analysis is under way for the fish response to the waterguns at an application in a backwater pond of the Illinois River.
- The pressure wave created by the waterguns has been measured and mapped during pond studies.
- The first phase of watergun pressure mapping was completed at Brandon Road in 2014.
- Conference calls with USACE to discuss project goals and potential technologies and solicit input.
- Hydraulic data collection work plan developed and shared with USACE and Brandon Road Coordination group. Incorporated feedback from USACE.
- Installed instrument to monitor velocity downstream of the Brandon Road Lock and Dam in summer 2014.
- Initial velocity data collected in 2014.

20. Characterization of Brandon Road Lock for Barrier Implementation

FY 2015 Actions:

- Perform synoptic velocity field mapping (intensive collection of water velocities in a short timeframe) at a range of low, medium, and high flows in the lock and the exit channel downstream.
- Perform velocity field mapping in the lock chamber and the exit channel downstream under "lock flushing" conditions as specified by the USACE engineering team.
- Collect bathymetry data in the Brandon Road dam spillway area to support USACE numerical modeling of the site.
- Install two velocity gages downstream of the Brandon Road Lock and Dam to collect continuous velocity data in the channel.
- Measure downstream boundary conditions to examine the effects of backwater in the Dresden Pool on hydrodynamics in the Brandon Road tailwater.
- Document the range of mixing environments present due to the expected range of hydrologic/hydraulic variation near the lock and downstream. Dye will be applied under normal flow and flushing conditions and tracked through the lock to document mixing zones and rates both within the lock and downstream of the lock.
- Collect water-quality data under various hydrologic conditions (locking, seasonal, high and low flows) to provide the information needed for the design of the system that will include basic field parameters in addition to major ions, including alkalinity and calcium, that will be needed to assess season variability and hydrologic extremes. USGS will coordinate with MWRD with its ongoing data collection efforts.
- Assess potential effects of CO_2 on structures, including potential assessment of current conditions of existing structures in conjunction with USACE.
- Work with USFWS to characterize flow field around barges to support entrainment studies.
- Complete native mussel survey, if needed, to assess potential impact of CO_2 use.

FY 2016 Actions:

- Analyze and compile synoptic velocity field mapping, downstream boundary conditions, and dye study results.
- Complete water-quality data collection and analysis.
- Begin writing reports documenting efforts for the USACE and contractors used to implement selected barriers. Reports expected on hydrology/hydraulic characterization and water-quality data for CO_2 on structures.
- Based on input from USACE and pending results from FY 2015 USGS IPM field trials, plan field tests of barrier technologies at Brandon Road.

Expected Milestones:

Winter 2015 Velocity mapping

Water-quality data collection into 2016.

Outcomes/Outputs: A better understanding of how potential new barrier technologies could be used at the Brandon Road Lock and Dam to prevent the movement of Asian carp.

Potential Hurdles:

- Field work components are subject to weather conditions.
- Coordination across agencies.

21. Use of Seismic Technology to Divert and Eradicate Asian Carp

Lead Agency: USGS

Agency Collaboration: IL DNR, USACE, USFWS, Northern Illinois University, Southern Illinois University, University of Illinois Urbana-Champaign, University of Minnesota-Duluth

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$410,500	$300,000	$0

Project Description: Preventing the movement of Asian carp from the Mississippi watershed into the Great Lakes rests largely on a set of electric barriers in the CSSC. Additional deterrents and complements to the CSSC electric barriers would likely improve the efficacy of deterring Asian carp from entering into the Great Lakes. Seismic sound generating technologies used for marine oil and gas exploration create high-pressure underwater sound energy waves that may be heard or felt by aquatic organisms. It is hypothesized that if seismic technologies can be intentionally operated to affect Asian carp behavior, then they may be useful to supplement the CSSC electrical barriers or be deployed in other locations for fisheries management applications.

Two general seismic technologies exist: (1) air guns, and (2) waterguns. Air guns release a volume of high-pressure air, causing a sound and pressure wave by the collapse and expansion of an air bubble. Waterguns use high-pressure air to rapidly drive water out of a water-filled chamber with a shuttle-piston. The rapid expulsion of water from the chamber creates a void that is rapidly back-filled as the shuttle returns to its firing position, creating a pulsed sound and pressure wave. If these tools are found to alter Asian carp behavior, they could be used to drive fish out of unwanted areas, or be used as a stand-alone deterrent in fixed locations (such as near electrical barriers, locks, connecting waterways, and spawning habitats). These different deployment scenarios will require varying deployment strategies based on numbers of guns and size of guns, specific depths of gun deployments, depth of the specific environment of deployments, and deployment effective distances must be considered. Moreover, the improper use of these tools could result in unforeseen damages to biological organisms and aquatic structures, so there is a need to carefully proceed with research activities to clearly define their limitations before implementation by management agencies. To address these variables, scientific research is needed to define how and where these tools can be used in a safe and effective manner.

USGS watergun research has been ongoing since 2012. The potential impact of seismic technologies on navigational structures and canal walls is of particular concern. To address the potential for structural damage by waterguns, pressure mapping data were collected in multiple locations to observe watergun pressure gradients at varying depths, measure the blast radii, and study multi-gun arrays in multiple orientations. Data were also collected near navigational structures. The two sites in 2014 included the CSSC (Lemont, Illinois) and below Brandon Road Lock and Dam (Joliet, Illinois). Using those data, engineers can begin to understand the geometry, directionality, and pressure forces of seismic blast waves and how they change with distance. Pressure mapping is expected to help define specific distances that seismic sources should be arranged to minimize risk of structural damages, yet at the same time delineate

pressure coverage areas that will affect fish behavior and be used to develop predictive models that detail the seismic forces on structures consisting of varying building materials (concrete and brick, for example).

To begin to understand how fish react to seismic energy, 13 different controlled studies were conducted between 2012 and 2013 in a USGS test pond. Multiple firing pressures and watergun orientations were observed, pressure mapped, and multiple species of fish were included. Behavioral response data for wild fish were also collected in 2013 and 2014 in two different field locations. Those data are being processed and analyzed. In general, it appears two waterguns arranged perpendicular to the long axis of a test pond or flowing channel in fixed locations were effective at reducing specific-sized fish abundance near the guns, but apparent deterrence of fish declines as distance increases outward from the guns. These outward decreasing levels of deterrence were expected based on pressure mapping data. However, these data are also still being processed for the many observational trials conducted to date, and it should be noted that fish abundance and behavior monitoring equipment varied from location to location and these different strategies are also being compared to develop standard operating procedures for future fish monitoring activities.

Other research needs include categorizing the response of Asian carp to mobile deployments of waterguns to drive fish out of an area, toward commercial fishing nets, or into areas where other control techniques could be applied. In addition, while some non-target effects data have been collected involving fish, the effects of waterguns on invertebrates (such as freshwater mussels) are unknown. Work will be initiated in 2014, and repeated in 2015, to evaluate the effects of waterguns on native mussels.

If waterguns prove to be an effective tool for fish deterrence, and standard operating procedures are developed to prevent adverse effects on navigational structures and biological organisms, these tools will be incorporated into fishery management strategies. To facilitate transition of seismic technologies into management programs, additional underwater seismic sound generation systems (air or waterguns and associated equipment) will need to be acquired and proper safety training will need to be provided.

The potential impact of the deployment of waterguns used to modify the behavior of Asian carp within the CSSC and the rest of the CAWS on the structures (controlling works and electric barriers) and canal walls is unknown. The watergun has previously been used in the maintenance cycle on the electric barrier to help remove fish from the area between Electric Barriers IIA and IIB. Potential use of the waterguns in downstream lock and dams, such as Brandon Road Lock and Dam, would keep more of the Asian carp downstream, which will reduce the population pressure moving through the electric barrier.

To assess the distribution of seismic energy from the waterguns, data have been collected in some locations in the CAWS and are being analyzed so that engineers can determine potential impacts on the structures and canal walls. Pressure maps under different watergun operating pressures and configurations are needed prior to deployment to ensure appropriate pressure coverage to prevent fish passage. The USGS and Northern Illinois University have begun developing a model to predict potential strengths of the seismic signals produced by the

waterguns on structures and pressure mapping, depending on varying waterway channel configurations. It is possible that work will be needed on watergun effects on ship hulls (particularly fiberglass) and ship equipment such as sonar based on USCG inquiry. It is anticipated that, pending data collection that indicates that the waterguns are safe on surrounding waterway structures, the USACE and various state natural resource departments will use watergun technology at key waterway and control points on the rivers of concern.

Summary of Actions to Date:

- Completed six trials (October-November 2012) in a USGS test pond.
- Completed pressure mapping in USGS test pond for single and dual 80-in^3 waterguns.
- Completed study to identify best methods to attach acoustic telemetry tags to juvenile Asian carp for short-term studies.
- Conducted seven behavioral response trials with Asian carp. Four trials evaluated the response of only Asian carp (Silver and Bighead Carp) to waterguns; three trials evaluated the response of Asian carp and four non-target fish species.
- Deployed waterguns in a 100-m-wide sidechannel of the Illinois River near Morris, IL. Completed pressure mapping around waterguns in a 100-m-wide side channel of the Illinois River near Morris, IL.
- Behavioral responses of Asian carp were monitored using fixed-location split-beam hydroacoustics (USGS) and mobile split-beam hydroacoustics and side-scan sonar (SIU).
- Completed an IPM demonstration in an Illinois River backwater.
- Held a collaborative partner demonstration day to inform USACE, IL DNR, USGS, and USFWS stakeholders about seismic technology, fish monitoring instrumentation, and commercial fishing to reduce local populations of Asian carp.
- Drafted a data report for the first watergun testing along the CSSC.
- Collected background noise pressure readings from barge traffic at BRLD.
- Completed Lemont, Illinois, CSSC pressure mapping around waterguns at depths ≤25 ft. deep.
- Data report completed for Lemont, Illinois, data acquisition.
- Completed Brandon Road Lock and Dam pressure mapping around waterguns in multiple orientations and distances from authentic navigational approach structures.
- Began developing predictive pressure map models for waterguns.
- Equipped a field testing site near Morris, Illinois with a 3D acoustic hydrophone array to improve fish behavior monitoring capabilities in conjunction with static and mobile split-beam hydroacoustics.
- Added two autonomous acoustic tag receivers to an Illinois backwater for monitoring long-term adult Asian carp movement by IL DNR and SIU.
- Completed two different static watergun barrier observations in an Illinois River backwater based on distance between waterguns (distance between guns was reduced ~10 percent between trials).
- Held a collaborative partner demonstration day to inform USACE, IL DNR, USGS, and USFWS stakeholders about seismic technology and fish monitoring instrumentation.
- Initiated consultations for mobile watergun deployment system designs.
- Completed purchase actions to acquire new waterguns, and acquired an old air gun.

- Initiated assessments of the effects of watergun exposure to native freshwater mussels to begin to address questions that may arise regarding aquatic species of concern (relative to USFWS Section 7 ESA consultation).
- Started management agency (USFWS) collaborations to begin safety training for the proper use of waterguns and associated equipment.
- Discussions of implementation strategies started with USFWS.
- Discussions initiated with IL DNR to identify additional field locations to observe mobile and static waterguns.
- Drafted publication of USGS test pond watergun fish behavior assessments.
- Completed pressure testing in Upper Midwest Environmental Sciences Center pond for both single and dual 120 in^3 waterguns. Data results summarized and sent to Rock Island USACE.
- Completed pressure testing in approach channel (2013) and west backwater pit (2014) at Hanson Materials, Morris, Illinois, site.
- Draft of data report from watergun testing along the Illinois Sanitary and Ship Canal at Lemont.
- Collected background pressure readings at lock entrance of Brandon Road Lock and Dam.
- Completed pressure testing of waterguns at Lemont and Brandon Road Lock and Dam.
- Initial discussions with USCG about safety issues related to watergun deployment.
- Through cooperative agreement with Northern Illinois University, began scoping of predictive model for pressures from waterguns.

FY 2015 Actions:

- Complete publication of USGS test pond watergun fish behavior assessments.
- Finish pressure map characterization, begin testing of predictive model.
- Complete reports describing the effects of waterguns on native mussel survival, shell damage, and movement.
- Repeat assessments of the effects of watergun exposure to native freshwater mussels to begin to address questions that may arise regarding aquatic species of concern (relative to USFWS Section 7 ESA-consultation).
- Determine a deployment strategy; including equipment needs, for mobile or fixed waterguns to deny Asian carp access to spawning habitat (spawning locations were identified in Illinois and Indiana in 2014).
- Conduct training of management agency staff for field deployment of waterguns and fish monitoring equipment.
- Evaluate pressure gradients from alternative (air gun) underwater seismic sound generation systems.
- Publish pressure maps and data from the watergun testing at the UMESC ponds, Lemont, and Brandon Road.
- Collaboration with Northern Illinois University on predictive model development.
- Data collection in UMESC ponds for testing impacts of waterguns on native mussels.

21. Use of Seismic Technology to Divert and Eradicate Asian Carp

FY 2016 Actions:

- Complete testing of predictive model.
- Begin publication of predictive model.
- Publication of analysis of different boundary conditions.
- Assist management agencies to deploy static waterguns to specific habitats.
- Begin mobile deployments of waterguns.

Expected Milestones:

- Determine behavioral responses of fish to watergun operation in an experimental pond.
- Determine behavioral responses of fish to watergun operation in field conditions.
- Determine best practices for fish monitoring equipment to assess control tool effectiveness in varying environmental conditions.
- Assess non-target species (multiple native mussels and additional fish species) effects of waterguns.
- Complete structural testing and pressure gradient mapping of different boundary conditions outside of the Brandon Road Lock and Dam, pending USACE permission.
- Pressure gradient mapping at CSSC Lemont, Illinois (25 ft. deep channel) and data collection at the rock/water interfaces.
- Develop a predictive model for watergun pressures on structures.
- Develop SOPs for safe watergun operation and deployment.

Outcomes/Outputs:

- Develop a scientifically based understanding of the minimum watergun size and array orientation needed, specific operating pressures needed, and watergun discharge frequency needed to deter Asian carp while minimizing risk of damage to navigational structures and injury to non-target biological organisms.
- Produce reports summarizing data collection methods, and best practices.
- Produce journal publications of studies seismic sound tools.
- Produce geophysical models for predicting seismic energy imparted on structures.
- Implement seismic sound tools for fisheries management.
- Data reports summarizing data collection methods, background data and data collected with waterguns.
- Journal publication of review and interpretations of studies summarizing the seismic energy imparted on structures.

Potential Hurdles:

- The current diesel high-pressure air compressor is restricted to operation in temperatures above 41°F (5°C) unless heated storage is available for the compressor.
- This project only has one diesel high-pressure air compressor and it is limited to a maximum output of 1,600 psi when two 80 in^3 waterguns are firing every 10 seconds.
- Expanding watergun arrays to include additional guns will require larger air production capabilities (additional compressors needed or larger units than the one existing compressor will be required; two 150 CFM compressors recommended for deploying up to six waterguns).
- A safe mobile watergun deployment configuration is needed to allow operation in areas where static watergun deployments are not possible.

- A boat mounted diesel compressor is recommended for mobile watergun deployments; this will require a large vessel to support the weight, standard USGS motorboat operator certification course (M.O.C.C. training) only allows for operation of vessels < 25 ft., 6 inches bow to stern.
- A limited number of waterguns are available and replacement parts are similarly in limited supply.
- Inability to rapidly mobilize waterguns and equipment in the CSSC and BRLD increases time and money needed to work in those areas and restricting navigation through test sites is very costly for local industry.
- Publication schedule is affected by the length of time required by data acquisition, analyses, syntheses, submission, acceptance, and processing times.
- Publication schedule is affected by the length of time required by reviewers and data acquisition.

22. Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp

Lead Agency: USGS/IL DNR

Agency Collaboration: University of Illinois Urbana-Champaign, USACE, USFWS, and SIU

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$200,000	$370,000	$0

Project Description: Currently, prevention of the movement of Asian carp from the Mississippi watershed into the Great Lakes rests on a single electric barrier located in the CAWS. Additional barriers or supplements to the electric barrier would improve the efficacy of deterring Asian carp movement into the Great Lakes through redundancy and safety nets, and offer greater confidence in their containment. For example, development of a chemical barrier that generated noxious water conditions might repel Asian carp, preventing them from approaching the electric barrier.

Some work has been done to define biological limits and potential benchmarks for candidate chemicals that may serve as a non-physical barrier to deter the movement of Asian carp. One candidate barrier chemical that has received a great deal of attention has been CO_2. Adding CO_2 to water has two main effects: (1) a reduction in pH due to the formation of carbonic acid (a weak acid), and (2) elevation of dissolved CO_2 (hypercarbia). The ability of animals to sense environmental $CO_2$is highly conserved and is common across kingdoms, spanning both prokaryotes and eukaryotes. Fish have externally oriented branchial CO_2-sensitive chemoreceptors that enable the detection of CO_2. The mechanisms responsible for inducing CO_2 avoidance are currently not known, but laboratory studies have shown that acute exposure of fishes to CO_2 would result in physiological disturbances related to stress, protein degradation and impaired oxygen transport, as well as alterations in behavior. Extended exposure to CO_2, or exposure to higher concentrations of CO_2, results in CO_2 passing the blood-brain barrier and altering brain biochemistry, resulting in equilibrium loss and, ultimately, death.

It is important to note that (1) additions of CO_2 do not function as a "bubble curtain" (not a physical obstruction), (2) CO_2 does not deter movement by causing hypoxia, and (3) the inevitable change in pH associated with elevated CO_2 is not sufficient to cause fish to move. Rather, it is believed that fish detect the presence of concentrations of CO_2 that are physiologically unacceptable, inducing avoidance as fish seek water containing near-normal concentrations of CO_2. Furthermore, CO_2 does not appear to be species- or size-specific, with fishes of all sizes and species apparently impacted in a similar fashion; a CO_2 barrier would therefore likely prevent the movements of non-target fishes as well. Combined, this information suggests a strong propensity for elevated CO_2 environments to act as a non-physical barrier to deter the movement of fishes across a range of species and sizes.

A large-scale pond trial to assess behavioral response of Bighead Carp, Silver Carp, and non-target fishes (Bigmouth Buffalo, Channel Catfish, Paddlefish, and Yellow Perch) has been completed. Discussions with the USEPA regarding regulatory framework for research applications of CO_2 in open-water applications including barrier operations have been initiated. An injection system has been manufactured that will allow for a large-scale, open-water

applications of CO_2. Trials evaluating the response of native mussels to CO_2 have been initiated and will be completed early in FY 2015.

FY 2015 Actions:

- Obtain regulatory concurrence to allow field evaluation in open-water applications.
- Complete field evaluation of a CO_2 barrier to deter Asian carp.
- Determine the effects of CO_2 on native mussels.
- Determine the use of CO_2 to enhance mortality in Asian carp during late winter.
    - Incorporate ecological information to identify potential sites for deployment of CO_2 to enhance winterkill conditions.
- Evaluate the cost of a CO_2 application into a lock chamber.
- Initiate review with USFWS to determine Section 7 ESA consultation data requirements of a CO_2 barrier or the use of a CO_2 as a control agent in limited open-water application sites.
- Define target concentrations of carbon dioxide required to deter fish.

FY 2016 Actions:

- Evaluate injection of CO_2 into a lock chamber to determine feasibility to create a barrier to Asian carp.
- Initiate studies to address USFWS Section 7 ESA consultation data requirements of a CO_2 barrier or the use of a CO_2 as a control agent in open-water application sites.
- Complete reports describing the responses of native mussels to CO_2.
- Complete behavior testing of fish in advective environments.
- Provide information on downstream impacts of CO_2 on receiving environment.
- Describe how different sizes of fish respond to CO_2 in a flowing water environment.

Expected Milestones:

- Complete field evaluation of a CO_2 barrier to deter Asian carp.
- Injection of CO_2 into a lock chamber to determine feasibility to create a barrier to Asian carp.
- Registration of CO_2 as a barrier or as a control agent in limited open-water applications.
- Completion of USFWS Section 7-ESA consultation.

Outcomes/Outputs:

- Define the ability of a CO_2 barrier, when deployed in the field at real-world scales, to impede the movement of free-swimming Asian carp.
- Recommendations to management agencies on the operating conditions to establish a static deterrent barrier.

Potential Hurdles:

- Capacity of the CO_2 infusion system to evenly disperse CO_2-infused water within an uncontrolled flow environment to maintain an effective deterrent barrier.
- Potential effects of carbonic acid on in-water navigation/control structures.

23. Developing Targeted (Microparticle and Piscicide) Control Systems

Lead Agency: USGS

Agency Collaboration: USFWS, Advanced BioNutrition, SouthWest Research Institute, Purdue University, South Dakota State University, University of Wisconsin-LaCrosse, Viterbo University

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$600,000	$200,000	$0

Project Description: No current technology can specifically target Bighead Carp or Silver Carp for control within aquatic ecosystems. Available control agents used in AIS control programs are non-selective and are applied throughout the entire water column, resulting in equal exposures of native and invasive species alike. Developing targeted delivery systems with high specificity for Bighead Carp and Silver Carp would increase the ability of management agencies to control or limit Asian carp while minimizing potential impacts on native species. Targeted selectivity can be achieved by understanding the habits and physiological characteristics of the target organism, and incorporating into delivery system technologies that will exploit those characteristics. Considerations such as food particle size, digestive physiology, feeding attractants/stimulants, and identification of species-selective chemicals can be brought together to develop a targeted delivery system.

The current lack of registered piscicides limits the tools that aquatic resources managers have available to control aquatic invasive fish. Developing a new suite of chemical tools specifically toxic to Bighead Carp or Silver Carp would provide a management option within an integrated pest management program designed to control populations of Asian carp and is essential to successful management of these nuisance species. This project will analyze structures and activities of chemicals with known piscicidal capabilities described in a variety of industrial, pesticide, and pharmaceutical libraries. Chemicals similar in structure or activities to known piscicides will be evaluated for potential use in controlling Bighead Carp or Silver Carp.

To date, a database of chemicals with known piscicidal activity has been created. The database now includes more than 400 compounds. A manuscript on the development of the database has been submitted for publication. This database is currently being evaluated to identify common structural features that can be used in structure-activity correlations for review and assessment of pharmaceutical and pesticide databases to identify candidate fish toxicants. Contacts are being developed with two agrichemical/chemical companies to gain access to chemical databases. Access to databases of additional agrichemical/chemical/pharmaceutical companies is being pursued. In addition the ZINC Database of more than 1.8 million compounds is being surveyed to determine suitable candidates. In collaboration with the USFWS LaCrosse Fish Health Center, sources of native fish cell lines suitable for use in cytotoxicity (cell toxicity) assays have been established. Work is ongoing to validate the assays. Digestive enzymes have been analyzed from fish captured from the Illinois (Illinois), Wabash (Indiana), and James Rivers (South Dakota), and a manuscript describing these data is under development for publication in a peer-review journal. Additionally, mean pore sizes of gill rakers of Silver Carp and interraker spacing of gill rakers of gizzard shad have been compared seasonally in the Illinois River and among the

Illinois, Wabash, and James Rivers. Two manuscripts have been completed. Antimycin was identified as a potential oral toxicant that can be incorporated into a microparticle that is readily consumed by Asian carp. Studies were completed to determine digestive enzyme kinetics, gastric evacuation rates, and apparent digestibility of food (and thus microparticles) by Bighead Carp and Silver Carp at three temperatures (12, 19, and 25°C). Drafts of two manuscripts have been submitted for publication. Buoyancy, leaching, and size analysis have been completed on sample batches of second- and third-generation microparticles. Information describing particle characteristics was provided to manufacturers to modify formulations. A contract has been established with two manufacturers of different types of particles. A spray atomizer has been built at UMESC that is capable of manufacturing microparticles using formulations developed for shellfish diets by the commercial aquaculture industry. Twelve different formulations have been manufactured and leaching studies completed. Static toxicity tests to determine LC_{50} have been completed for native fishes (largemouth bass, bluegill, golden shiner, fathead minnow, and paddlefish) and Asian carp. Initial feeding trials that assess the selectivity of microparticles have been completed in laboratory trials. It was determined that pH may have a significant role in the toxicity of antimycin in Asian carp but a minor role in native fishes.

FY 2015 Actions

- Continue in vitro cytotoxicity assays to quickly screen through potential new control chemicals.
- Initiate *in vivo* fish assays with only those chemicals that demonstrate high toxicity and selectivity for Asian carp.
- Assess manufactured microparticles to ensure for limited to no leaching of control agent occurs and that fish will consume the microparticle.
- Validate initial results of UMESC microparticles in laboratory trial.
- Evaluate the effectiveness of UMESC microparticles in pond studies and attempt to minimize the impacts on native filter feeding fishes like paddlefish.
- Evaluate effectiveness of combining algal feeding stimulus with microparticle delivery to improve acceptance and efficacy of microparticles.
- Assess the role pH has on the toxicity of antimycin in Asian carp and determine if the combination of lowering pH and antimycin can increase specificity of microparticles.
- Initiate an aerobic aquatic metabolism study to determine degradation characteristics of toxicant-incorporated microparticle technology to begin to establish environmental fate.
- Complete non-target testing of microparticle with antimycin in non-target native species to ensure specificity.
- Evaluate potential field sites along the Illinois River for field trials with microparticles.
- Initiate field trials and assess population changes in populations of Asian carp subsequent to deployment of microparticles.
- Develop population models that incorporate mortality from commercial fishing and microparticles.
- Incorporate ecological information to identify locations for deployment of microparticles.
- Initiate studies to identify biologically derived controls (pathogens) of Asian carp as an alternative to chemical controls.

23. Developing Targeted (Microparticle and Piscicide) Control Systems

FY 2016 Actions:

- Initiate studies to support USEPA registration of antimycin-incorporated microparticles.
- Initiate studies to support FWS Section 7 ESA consultation requirements regarding the use of antimycin-incorporated microparticles.
- Continue *in vitro* cytotoxicity assays and initiate *in vivo* fish assays.
- Continue studies to determine biologically derived controls of Asian carp.
- Evaluate alternative control agents to incorporate into microparticle delivery system.
- Assess registration requirements of alternative control agents of Asian carp.

Expected Milestones:

- In vitro cytotoxicity assays to assess chemical toxicity for Asian carp and native fishes.
- A selective targeted delivery system of antimycin to Asian carp.
- Aerobic aquatic metabolism study to determine degradation characteristics of toxicant-incorporated microparticle technology.
- Non-target testing of a selective targeted delivery system of antimycin to non-target native filter feeding species.
- On-site field evaluations (either in UMESC mobile laboratory or in situ pending permitting) of microparticles containing antimycin.

Outcomes/Outputs:

- Approximately one dozen candidate fish toxicants identified for further testing.
- Development of a selective targeted delivery system of antimycin for selective control of Bighead Carp and Silver Carp.
- Development of a selective targeted delivery system of another chemical control agent or a biologically derived control agent for selective control of Bighead Carp and Silver Carp.

Potential Hurdles:

- Access to candidate fish toxicants from private chemical libraries.

24. Chemical Attractant Investigations to Increase Harvest and Control

Lead Agency: USGS-CERC

Agency Collaboration: USFWS, IL DNR, INHS

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$274,000	$204,000	$0

Project Description: Laboratory and field studies conducted at CERC and by independent researchers have consistently confirmed that an algal food stimulus is highly attractive to Asian carp and can increase the abundance of fish in areas where Asian carp have been conditioned to the food. Such attractions are sufficiently persistent to enhance capture and ensure ingestion of microparticles containing a control agent. Alternative, less expensive feeding attractants will be required as the scale of field studies expands. Aqueous preparations of live cultures of various species of algae and aquatic plants and green vegetables will be evaluated for their attractive potential for Asian carp. Chemical composition of attractive foods will seek to identify the unique chemical compounds responsible for the attractant quality. To facilitate the selection of potential attractants, electro-olfactogram (EOG) capabilities will be developed at CERC as a rapid screening tool for selecting attractants to be applied in feeding testing.

The main objective of the feeding attractant studies is to increase harvest of carp by state agencies. Field studies will evaluate optimal application methods of the attractants to aid in the capture of wild carp using various harvesting gears. Factors to be considered for increasing the efficiency of fish harvest are gear types, site location, river dynamics (flowing, backwater), seasonality, and productivity of the system. Conditioned acoustic stimuli (conspecific, ambient, and synthesized) associated with the algal attractant will be included in the protocol to enhance attraction over greater distances than the algal plume. These efforts will benefit state agencies deploying control methodologies.

Feeding attractants will also be integrated with microparticle delivery technology to enhance control and management of Asian carp. Microparticles will be introduced to fish that have been conditioned with food attractants in field tests to facilitate ingestion of microparticles containing a control agent. This study will include characterizing the feeding response to the microparticles, documenting response at the feeding stations, incorporating components to increase the efficacy of microparticle-delivered control agents, and determining potential management of Grass Carp through the use of control agents incorporated into particles adhering to submerged aquatic vegetation or other delivery methods targeting Grass Carp.

Sonar technologies, verified and validated with DIDSON imagery, will be used to observe the response of wild carp to the algal stimulus in the field to document behavior in and around netting/trapping devices. Responses to be quantified include the number of fish in and around netting/trapping devices, the number of fish that enter and leave the mouth of the nets, characterizing the fish response to the algal stimulus when released near the net, as well as their response in the net. Fish activity and abundance will be evaluated within 50 feet of the algal stimulus plume.

24. Chemical Attractant Investigations to Increase Harvest and Control

Summary of Actions to Date:

- Video analyses of laboratory studies confirming Asian carp attraction to the algal stimulus solution have been completed.
- Attraction to algal stimulus solutions was verified in a mesocosm pit tag array using tagged juvenile Asian carp. The response of the carp was also verified using digital video imaging with underwater GoPro cameras that revealed active feeding responses among the fish attracted to the targeted area of release where the algal stimulus was presented. The response elicited by this stimulus was robust relative to the number of fish attracted to the area and the duration of time fish remained in the immediate vicinity of the algal plume. Fish began to move from the area as the algal stimulus dissipated as a result of consumption by the carp and dilution. The response was highly consistent among the 12 trials conducted. There was a high degree of turbidity present during these tests as a result of ambient native algal blooms; however, the presence of this algae did not diminish the response to the algal stimulus.
- Tests confirmed that carp can be conditioned to feeding stations and that such strong attraction can be used to facilitate their capture.
- Studies determined that wild carp could be conditioned to feeding stations at four sites of varying complexity relative to width, depth, flow, and cover along the Missouri River. Apparatus and procedures were developed for applying the algal stimulus each day. Initial observations using DIDSON imagery indicated the attraction for fish including carp to this feeding. Studies expanded to habitats behind box dike structures along the Missouri River consistently document attraction of Asian carp to the algal stimulus.
- A demonstration project of integrated control technologies was conducted at Morris, Illinois in August 2013 and 2014 to develop protocols for luring carp into a specific area to facilitate application of management strategies (e.g., application of control agents through microparticle delivery). An array of detection technology, including DIDSON sidescan sonar and telemetry, were used to document fish response to treatment.
- In September 2014, a pilot study was conducted in the East Pit of the Hansen Materials Service Site in Morris, Illinois, to determine if conditioning Asian carp to an algal stimulus (food attractant) in an area where pound nets are deployed will increase fish catch rates.

FY 2015 Actions:

- In expanded studies with USFWS, state agencies, and commercial fishermen, the algal stimulus will be applied as a lure in a variety of active and passive nets and traps to identify gear most effective for increasing abundance and harvest.
- Release of the algal attractant and recording of response through sidescan sonar will be automated.
- Auditory stimuli will be paired with the presentation of the algal stimulus to increase responsiveness to the feeding station to enable greater harvest abundance. The stimulus may include conspecific, ambient, or synthesized sounds. An important facet of this research will be in optimizing the fishing effort relative to the time of year, habitat characteristics, gear selection, and appropriate conditioning to the feeding station.
- EOG analyses will be performed with potential alternative feeding attractants using Asian carp to screen for potential attractants based on the magnitude of physiological response.
- Determine behavioral attraction, quantifying the level of activity and persistence associated with the alternative food stimulus sufficient for and prolonged attraction and harvest.

24. Chemical Attractant Investigations to Increase Harvest and Control

- Olfactory physiological and behavioral studies with component compounds found in the algal stimulus will be conducted to facilitate development of an attractant for microparticles containing a control agent(s) in pond mesocosm studies.
- Evaluate the response of other species, including Grass Carp to the algal attractant and other food stimuli.

FY 2016 Actions:

- Studies with selected gear types will be expanded to evaluate performance in different habitats and at different times of year.

Expected Milestones:

- March 2015: Automated data recording instrumentation will be completed and validated with DIDSON imagery. EOG workstation completed.
- EOG tests of aqueous food stimuli conducted through 2015, with concomitant behavioral tests of apparent attractants.
- Field trials with different nets and traps will be employed at feeding station locations to develop protocols and to determine if the feeding station increases harvest abundance.
- Electroshock applications will be conducted to determine if fish can be driven to concentrate fish at feeding stations and thereby increase capture efficiency.
- Controlled pond studies will be conducted to determine if it is feasible to integrate algal attractants with the delivery of control agents captured within microparticles and to evaluate optimal sensory stimulation to ensure Asian carp ingest microparticles containing a control agent.

Outcomes/Outputs:

- Create expanded protocol for the application of chemical attractants incorporating auditory stimuli.
- Integrate chemical lure with microparticles to increase ingestion of control agents by Asian carp.
- Merge chemical attractant and harvesting methodologies.
- Report on feasibility of the use of chemical attractants and repellants in the capture and harvest of Asian carp.
- Conduct workshops on Integrated Pest Management Strategies and assist state agencies in their applications.
- Transfer of technology to state agencies.

Potential Hurdles:

- High river stages from unseasonal rainfall hinder research.

25. Use of Acoustic Technology to Determine Behavior

Lead Agency: USGS CERC

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$144,000	$0	$0

Project Description: Asian carp have been expanding their range in North America since they were introduced in the early 1970s. They are now abundant in the Mississippi, Illinois, and Missouri River drainages and now threaten to enter the Great Lakes. These fishes are very skittish when approached by boat and are famously known for leaping out of the water when stressed by boat noise or when confronted with barriers like the shoreline, wing dikes, and gill nets. In many cases, Asian carp are seen simply leaping over nets and avoiding catch.

DIDSON is a high-frequency sonar camera that produces images at a rate high enough observe fish swimming patterns and guilds of fish species based on crude body shape and behavior. DIDSON sonar has been used in the past to conduct fish counts of salmonids passing specific areas in a river; investigate spawning behavior, and trawl net avoidance. With this tool, we can accurately observe fish with minor interference. The ability of the DIDSON to discretely observe in situ Asian carp behavior at night or in turbid water will broaden the understanding their behavior.

Asian carp are famously believed to have highly developed net avoidance behavior, which inhibits control methods based on harvest. However, simply comparing catch rates between different net types to assess their efficiency of carp harvest is hampered because different sets will be tested by different and unknown numbers of carp. Furthermore, improvement of harvest gear design is hampered by lack of knowledge of the types of behaviors that allow Asian carp to avoid nets. We plan to assess the behavior of Asian carp in relation to different gear types and propose gear modifications that might enhance harvest efficiency.

CERC primarily uses 100 yards, 3.5-inch mesh, 10-foot depth, and floating trammel nets to catch Asian carp. Over the years, thousands of Silver and Bighead Carp have been caught for various purposes, and it remains one of the most effective means of catching these fish. However, preliminary observations with the DIDSON have shown strong avoidance of trammel nets, as well as trap nets, by Asian carp. DIDSON images show hundreds of Asian carp, singly and in groups, approaching the net and then rebounding from them and quickly swimming away.

Some flexibility in study plan during the year may be required because of the potential identification of fish behaviors that merit more focused research efforts. Promising lines of research may be identified during the study that require a change in direction or focusing on some gear deployment types or behaviors at the expense of less promising lines of research. However, at this time, we plan to test four entanglement net types: trammel nets, and multifilament, monofilament and multi-strand gill nets. All entanglement nets will be 3.5-inch mesh, floating, 10-feet deep, and 100 yards long. Gill nets will be “tie-down” gill nets that have

been tied down to a third of their depth (15 feet deep to 10 feet deep), a gear modification that has been reported to improve catches of Asian carp. In addition, behavior of fish in relation to hoop nets and fyke nets will be evaluated.

Fish behaviors will be classified and quantified. Planned parameters for quantification include, but are not limited, to: (1) proportion of fish that approach gear, (2) proportion of fish that enter/test gear but escape, (3) change in speed as nets are approached (or increase/decrease in tail beats, or distance from net that change in speed is observed), (4) bounce back behavior, (5) changes in behavior if other fish are already entrapped by the gear, and (6) changes in behavior or gear success when fish are "driven" by a moving boat. Water quality will be measured at each site, especially including water temperature, velocity, and turbidity, parameters that may influence avoidance behavior or net detection. Catches will be compared in Sigmaplot 12.1 with categorical statistics via X2and ANOVA for the fish counts. The DIDSON video will be brought into Echoview 5 for fish counts, fish lengths, and fish travel directions. Video will be manually observed for net encounter behavior and tallied.

The goal of the project is to observe and quantify Asian carp behavior that results in net avoidance and form testable hypothesis regarding gear modifications that ameliorate or negate such behaviors. In addition, these data will be used to assess the probability of capture of fish by different gear types, especially regarding the selectivity of specific gear types or mesh sizes for different sizes of fish. This information will be especially useful in estimating the potential effectiveness of early detection efforts.

Summary of Actions to Date:

- On July 11, 2013, USGS tested the older model DIDSON sonar to get some training in on using the equipment. The test Location was Moniteau Creek near Marion, Missouri. Using DIDSON model 300m, we recorded fish reactions when encountering trammel nets. When the DIDSON data were received, distinct behaviors were noticed that were unknown to exist.

Behavior 1: Instant Reversal or Bounce Back

- This striking behavior was noted dozens of times for each net set. Carp of many sizes would be seen swimming toward the trammel net. When nearing the net, the caudal fin appears to stop its swimming motion and the fish would drift for approximately a meter or so until they either contact the net or approach extremely close to it. At that time, the fish reverse course sharply and swim rapidly away from the net (Figure 1 on the next page).

Behavior 2: Bounce Along

- On a few occasions, Silver Carp would be seen encountering the trammel net, then doing a bounce back in an arch only to encounter the net again a few meters away and bounce back again. In this case, the fish appears to be searching for an opening to pass the net.

25. Use of Acoustic Technology to Determine Behavior

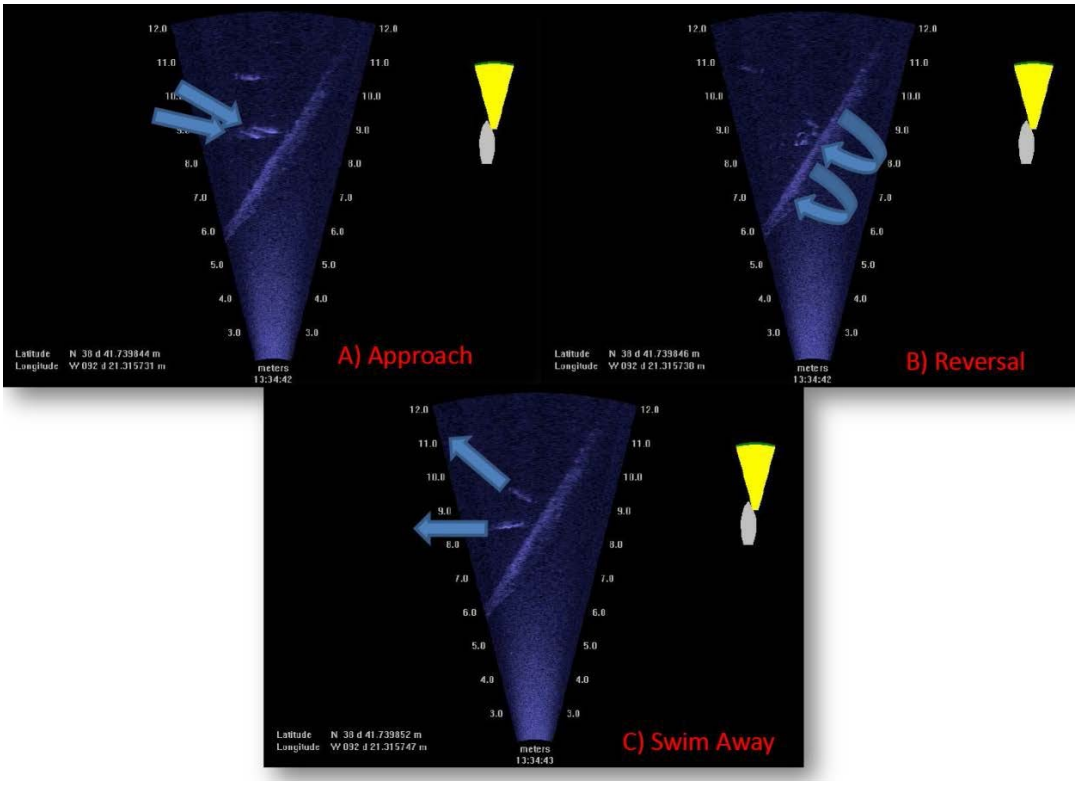


Figure 1. Screenshots of DIDSON footage showing the "bounce back" behavior of Silver Carp when approaching a trammel net. A) Silver Carp approach the trammel net at 13:34:42. B) Silver Carp sense the trammel net and reverse course C) Silver Carp are swimming away from the trammel net at 13:34:43.

FY 2014 Actions:

- Determine site locations. Entanglement gear sites must be able to install a 100-yard net so no fish can swim around the net. Test the ARIS DIDSON at the sites to ensure plenty of depth for placement and make a test run with a Trammel net. Schedule the use of the DIDSON with other researchers using the same device. Conduct the study, one site per day. Begin analysis of data to compare gear types and catch efficiencies. Develop testable hypotheses regarding net design improvement and design studies to test those hypotheses. For example, one testable hypothesis might be that Silver Carp in the "bounce along" behavior that encounter an opening would enter that opening. Such behavior could be used to design a net that provides openings that carp would enter and become trapped.

FY 2015 Actions:

- Continuing project field work and data analysis. Prepare manuscript describing behavior of Asian carp encountering harvest gear, and submit for review. Present as a presentation at the 2016 Midwest Fisheries and Wildlife Conference. Begin testing of hypotheses generated in FY 2014.

25. Use of Acoustic Technology to Determine Behavior

FY 2016 Actions:

- Publish results of previous year's work, and, if appropriate, continue new lines of harvest enhancement study based on the results of this study.

Expected Milestones:

- Summer 2014: Begin data collection and identification of behaviors that can be enumerated, generate hypotheses for testing.
- Fall 2014: data analysis and new hypothesis generation, and, if appropriate, construct gear with modifications for hypothesis testing.
- Winter 2014/2015: Begin data collection to test new hypotheses, and prepare manuscript describing behavior of Asian carp encountering nets.

Outcomes/Outputs:

- Outcomes from this project will be a description of behaviors of Asian carp encountering the different harvest gears. These behaviors will be quantified and the effect of gear type on behavior and capture efficiency will be assessed. New gear types or deployment methods that could enhance harvest will be designed and tested.

End Users of the Product:

- USGS anticipates that deployment modifications that enhance catch rates will be used by researchers, managers, and commercial fishers wherever appropriate and legal. In addition, this project can be used by managers to assess the potential that carp will be captured in places where they are rare and in which early detection is desired.

Potential Hurdles:

- Scheduling conflicts between groups at CERC on DIDSON use given the center currently has only two DIDSON units, of differing capabilities.
- Weather can always lead to delays.
- Damage to nets will need time to repair if not replaced.

26. Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish

Lead Agency: USGS

Agency Collaboration: USFWS, Purdue University, MN DNR and Wisconsin DNR for field assistance and University of Minnesota (UM), University of Wisconsin (UW), Illinois Natural History Survey, South Dakota State University, University of Illinois at Urbana-Champaign, University of Missouri-Columbia (UMC)

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$790,000	$250,000	$0

Project Description: Early detection is a vital part of managing any invasive species, including the invasive Asian carp species Bighead Carp and Silver Carp, collectively referred to as Asian carp. Significant efforts have been made to detect Asian carp at low abundances and identify their invasion front, but since Asian carp avoid traditional capture gear, traditional gear have limited utility in finding Asian carp at low density. An alternative method for monitoring Asian carp is the detection of molecular signals (such as mitochondrial DNA – often termed eDNA) of Asian carp in water samples.

The eDNA method has proven effective for detection of Asian carp at low densities. Further improvements to eDNA technology will offer managers a "molecular toolbox" for detection and characterization of Asian carp occurrence. Current applications include detection of spawning events, fish movement, habitat utilization, and evaluation of the effectiveness of management actions. Applications of eDNA technology under development include estimation of fish biomass and methods for determination of time since eDNA was shed from a live fish. Refinements to eDNA methodology are also being pursued to improve detection sensitivity, prevent false negatives caused by PCR inhibition, increase cost-effectiveness, and decrease time between sampling and results.

An innovative combination of human medical testing methodology with eDNA is also under development. Markers are being designed and optimized for incorporation into a rapid, portable DNA/RNA detection kit for use in the field to screen samples for the presence of DNA from Asian carp. For example, DNA of Asian carp in water from baitfish shipments could mean that Asian carp are present in the baitfish shipment. The Asian carp markers will be incorporated into commercial, hand-held DNA detection kits similar to those available for human disease agents.

Further work is needed in correlating eDNA signals with actual live organisms. This project will aim to establish this relationship by investigating differential degradational patterns of DNA and identifying breakage hot spots for development of new mitochondrial markers, development of eRNA or nuclear DNA markers, development of unique gut microbial markers, and assaying water samples for specific Asian carp metabolites (pheromone, hormones, and similar).

26. Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish

Summary of Actions to Date:

- Identified significant spike in Asian carp eDNA correlated with spawning events in the Wabash River and applied "stair-step" markers to eDNA samples, detecting Asian carp sequences of greater than 800 base pairs that indicate freshly shed eDNA from live fish.
- In the Missouri River, identified a similar spike in Asian carp eDNA correlated with a spring rise in water level, likely to indicate a spawning event.
- Described a linear relationship over four orders of magnitude between Asian carp biomass and eDNA shedding rate under controlled laboratory conditions.
- In laboratory experiments, showed that temperature does not alter eDNA shedding rates but feeding increases eDNA shedding by about 10-fold.
- Described degradation curve of eDNA from Asian carp sperm under controlled laboratory conditions, showing a good fit to exponential decay with a half-life of about 8 hours.
- Three manuscripts/reports are accepted and four others in preparation from UMESC.
- One manuscript is in press and three are in preparation from CERC.
- Validated new qPCR markers through a multi-laboratory round robin double-blind study for Asian carp mitochondrial DNA to allow incorporation into USFWS eDNA monitoring program.
- Initiated validation of Asian carp-specific microbial communities to detect Asian carp.
- Initiated mitochondrial sequencing of select native cyprinids whose mitochondrial DNA sequences are underrepresented in GenBank.
- Identified enteric microbial populations from more than 150 individuals, comprising more than 15 different native species of fish, from the Illinois River.
- Designed microbial marker to identify SVC in water samples.
- Developed Asian carp markers for a rapid, portable DNA/RNA detection kit and began validation of assays with silver and Bighead Carp cell line DNA.
- Completed transect-sampling of eight sites repeatedly, once in spring and then again in mid-summer, of the Upper Mississippi River between pools 2 and 26 with a gradient of known relative population densities of Asian carp.

FY 2015 Actions:

- Design, test and validate qPCR assays from the Asian carp mitochondrial DNA genome to span multiple rapidly degraded sites to develop markers useful for tracking live fish.
- Design, test, and validate eRNA or nuclear DNA markers as an alternative signal for tracking live fish.
- Develop next-generation sequencing protocols to analyze composite water samples, plankton tows, and ichthyoplankton tows for species composition/richness determination, Asian carp biomass, and spawning events/locations.
- Develop qPCR method to detect Asian carp-specific microbial populations and determine how microbial populations change seasonally.
- Test and validate Asian carp microbial source markers for potential inclusion into surveillance program in an effort to track live fish.
- Investigate usefulness of occupancy modeling on previously collected water samples from low Asian carp abundance to high Asian carp abundance on the Upper Mississippi River, Illinois River, and Wabash River.

26. Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish

- Investigate the use of metabolites to track live fish such as pheromones and hormones.
- Identify colonies of fish-eating birds with overlapping feeding radii near known and suspected locations with populations of juvenile Asian carp.
- Initiate sampling and analysis of fecal material collected in nesting colonies of fish-eating birds.
- Validate "stair-step" cPCR markers for Asian carp mitochondrial DNA to allow incorporation into USFWS eDNA monitoring program.
- Validate internal positive controls for incorporation into USFWS eDNA monitoring program to prevent false negatives from PCR inhibition.
- Complete analysis of Missouri River temporal eDNA sampling series to correlate the spike in eDNA with quantity and age of Asian carp eggs and larvae in matched samples, and maximum size of eDNA fragments.
- Complete studies to optimize eDNA sampling locations by mapping occurrence of PCR inhibitors in flowing water systems, coupled with qPCR studies of eDNA performed by USFWS and Purdue University.
- Validate and complete in-life and field efficacy trials on Asian carp markers for a rapid, portable DNA/RNA detection kit.
- Initiate the purchase portable DNA/RNA detection kits and arrange a training for state and federal law enforcement.
- Complete analysis of eDNA quantity in 2014 samples from upper Mississippi sites with a gradient of known relative population densities of Asian carp.
- Repeat sampling of upper Mississippi sites with a gradient of known relative population densities of Asian carp, in collaboration with the Long Term Resource Monitoring Program or in areas with commercial catch data, to characterize any changes in populations over time.
- Correlate degradation of Asian carp eDNA and Asian carp-specific microbe sequences in water matrices taken from CAWS.
- Complete mitochondrial sequencing of fishes native to Upper Mississippi River whose mitochondrial DNA sequences are underrepresented in GenBank.
- Conduct Asian carp population density study in small pond mesocosms to connect laboratory and field results for eDNA quantity.
- Estimate relative Asian carp density in Missouri or Mississippi River tributaries and wetlands with side-scan sonar and traditional capture methods, and conduct simultaneous sampling for eDNA quantification to characterize habitat usage and fish movement.
- Conduct comparisons of water sampling methods during the field and pond studies, to optimize water sampling methods for eDNA detection and quantification.

FY 2016 Actions:

- Complete development of eRNA or nuclear markers and evaluate usefulness in captive tank or field samples known to contain presence recently introduced live fish.
- Field validation of rapid, portable DNA/RNA detection kit for Asian carp and deployment to management agency biologists.
- Complete development of detection technology for Asian carp metabolites and validate with captive tank water samples or samples collected in the field.

26. Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish

- Carry out technology transfer of developed next-generation sequencing protocols to USFWS or other management agencies in analyzing individual or composite water samples, plankton tows, or ichthyoplankton tows to correlate with species composition and abundance.
- Complete the development of qPCR assays from Asian carp DNA that span multiple restriction site regions of interest in an effort to develop markers useful for tracking live fish.
- Transition the use of Asian carp-specific microbial communities as a complement to eDNA to monitoring programs.
- Complete studies assessing the use of fish-eating birds to track Asian carp.
- Complete analysis of eDNA quantity in 2015 samples from upper Mississippi sites with a gradient of known relative population densities of Asian carp.
- Repeat sampling of upper Mississippi sites with a gradient of known relative population densities of Asian carp, in collaboration with the Long-Term Resource Monitoring Program or in areas with commercial catch data, to characterize any changes in populations over time.
- Complete analysis of mesocosm study of relationship between Asian carp population density and eDNA quantity.
- Validate qPCR assays of rapidly degraded sites in the Asian carp mitochondrial DNA genome to allow incorporation into USFWS eDNA monitoring program as an indicator of eDNA recently shed from live fish.
- Compare the quantity, maximum length, and time course of eDNA released from live fish and dead fish in ponds.
- Complete data analysis comparing eDNA quantification with estimates of relative Asian carp density in Missouri River tributaries and wetlands from side-scan sonar and traditional capture methods, to characterize habitat usage and fish movement.
- Conduct training for state and federal natural resource law enforcement on the use of the near real-time RNA/DNA detection kit.

Expected Milestones:

- Establishment of next-generation sequencing protocols to assist in answering management questions above and beyond the presence of eDNA that hinge on fish movement, spawning events, fish abundance, and related factors.
- Development of mitochondrial DNA, eRNA, nuclear DNA or metabolite assays linked to the presence of live fish.
- Use of eDNA to target control technologies.
- Use of eDNA to determine barrier effectiveness, at Brandon Road Lock and Dam control structure.
- Use of established eDNA or eRNA occupancy models to target sampling and establish sampling strategies to increase probability molecular signals are the result of a live fish source.
- Validation and transition of new markers to monitoring programs.
- Development of models for estimation of Asian carp biomass from eDNA quantity.
- Identification of methods to detect and minimize inhibition of PCR for eDNA analysis, and transfer of these methods to USFWS eDNA monitoring program.
- Development of molecular monitoring protocols that extend beyond the determination of

the absence/presence for Asian carp.
- Evaluation of the utility of the use of fish-eating birds to identify populations of Asian carp.
- Transfer technological and methodological advancements to Asian carp monitoring programs.

Outcomes/Outputs:
- Multiple validated methods to detect a variety of Asian carp molecular signals including mitochondrial DNA (target of current eDNA surveillance programs).
- Tools to accurately identify the route of entry of Asian carp molecular signals (such as eDNA) into a water body to discriminate between potential vectors and the presence of live fish.
- Characterization of eDNA signals associated with spawning events, fish movement, invasion fronts, and abundance.
- Use of eDNA quantity to estimate Asian carp biomass.

Potential Hurdles:
- Identification of native species with similar DNA sequences.
- Collection of rare species for mitochondrial screening, though access to museum specimens may negate this hurdle.
- Collection of samples through winter months.
- Access to fish-eating bird colonies.
- Natural variation among samples in eDNA quantity due to clumped nature of shed cells containing eDNA.

27. Integrated Pest Management Program

Lead Agency: USGS

Agency Collaboration: IL DNR, USACE, USFWS, SIU, University of Illinois Urbana-Champaign, University of Minnesota-Duluth, Purdue University

Funding Tables:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$1,741,729	$1,159,000	$0

Project Description: Many potential tools, including chemical controls, are being evaluated for use within integrated pest management control programs of federal or state natural resource agencies. In general, those tools are being evaluated separately, and not as part of an integrated strategy to reduce populations of Asian carp. In 2013, USGS, IL DNR, and SIU completed a collaborative effort to evaluate the integration of multiple tools to control Asian carp. The 2014 effort integrated feeding attractants of Asian carp, waterguns to block fish escape, and commercial fishing to deplete local populations of Asian carp. The goal of the 2015 work will be to extend the evaluation of integrating multiple tools, such as those used in 2013 and 2014, to multiple locations in the Illinois River and other watersheds near the Great Lakes where Asian carp are present such as the Wabash River. This project integrates the products of several larger projects that are developing tools to control Asian carp to evaluate whether integrating these tools increases the ability to reduce Asian carp' populations.

The USGS, IL DNR, SIU and other potential collaborators will identify potential locations where multiple control tools may be integrated to assess whether integration (1) increases removal of Asian carp by commercial fishing, (2) decreases spawning success, or (3) denies Asian carp access to critical habitat. Two or more sites will be identified where feeding attractants, waterguns, CO_2, sound, and commercial fishing may be used (or combinations thereof). Feeding attractants will be applied to attract Asian carp then waterguns will be positioned to block the escape of Asian carp during commercial fishing. Studies will be designed to assess whether catch by commercial fishing increases when combined with feeding attractants or waterguns or both. There are currently 300 acoustically tagged silver and Bighead Carp in the upper-middle Wabash River, and at least 200 of these fishes should continue to have active transmitters to allow telemetry studies in 2015 and later years. We propose to use telemetry of existing tagged fish and known preferred habitats in the Wabash River to continue to track movements and habitat use and to evaluate the effectiveness of using underwater acoustic stimuli to exclude these fishes from preferred in situ habitats. Given their sensitivity to acoustic disturbance, it is likely that these fishes can be excluded from preferred habitats in existing and future systems where they become introduced and established.

Summary of Actions to Date:

- Completed an integrated pest management action near Morris, Illinois August 4 to 14, 2014, in a backwater area in a privately owned sand mine. The backwater is connected to the Illinois River and is fished by commercial fisherman under contract with IL DNR. A fixed array telemetry with 32 hydrophones (16 on each side of the watergun deployment) was installed. Twelve autonomous hydrophones (six on each side of the barrier) were

also installed. A total of 185 fish (53 Bighead Carp, 64 Silver Carp, and 68 Buffalo Carp) were tagged. Telemetry was conducted continuously throughout the study. Fish distribution and population assessments were also conducted throughout the study area during the trial using split-beam hydroacoustics. Mobile hydroacoustic surveys were conducted twice daily, morning after sunrise and evening after sunset. Stationary hydroacoustic data were collected continuously during the study period. Algal feeding stations (two actual and two control) were established on both sides of the barrier. A static watergun deployment operated from 1547 August 8, 2014, through 1051 August 14, 2014. Periodic interruption in deployment operation occurred to allow gun and/or compressor maintenance.

FY 2015 Actions:

- Purchase and establish a telemetry system at the IPM site that can be used for the evaluation of waterguns, sound, and carbon dioxide.
- Establish study site for evaluating waterguns, sound and CO_2.
- Identify potential sites to perform integrated pest management strategy focused on antimycin-incorporated microparticles.
- Continue to identify spawning locations for targeting areas for watergun deployment.
- Continue to identify characteristics of habitats where Asian carp congregate for deployment of lethal CO_2 or microparticle controls.
- Evaluation of Asian carp diet for the advancement of microparticles, identification of habitats suitable for manipulations to limit recruitment, and validation of microbial markers.
- Conduct mini-Fyke net sampling to identify spatiotemporal aggregations of juvenile Asian carp in the Wabash River for potential future IPM activities (Purdue).
- Begin determining effectiveness of acoustic stimuli for excluding Asian carp from preferred habitats.
- Complete two or more IPM evaluations. Techniques will focus on the use of waterguns, CO_2, sound and/or antimycin-incorporated microparticles.
- Evaluate the use of sound to drive Asian carp into targeted areas for increase removal.
- Complete a report describing the IPM operation conducted in FY 2013/2014.

FY 2016 Actions:

- Complete two or more IPM evaluations. Techniques will focus on the use of CO_2 or other chemical barriers, sound and/or antimycin-incorporated microparticles.
- Conduct mini-Fyke net sampling to identify spatiotemporal aggregations of juvenile Asian carp in the Wabash River for potential IPM activities (Purdue).
- Test effectiveness of acoustic stimuli for excluding Asian carp from preferred habitats (Purdue).
- Complete a report describing the integrated pest management operations conducted in FY 2015.

27. Integrated Pest Management Program

Expected Milestones:

- Identification of critical life stages or critical or limiting habitat to focus integrated control efforts.
- Identification and demonstration of approaches to apply IPM techniques to control Asian carp.
- Field evaluations of the integration of multiple techniques to control Asian carp.

Outcomes/Output:

- Understanding of how to integrate multiple technologies to alter the behavior of Asian carp and to control and deplete localized populations of Asian carp.
- Recommendations to management agencies on operating conditions to establish static deterrent barriers or mobile herding systems.
- Preliminary infrastructure developed to evaluate Wabash River Asian carp susceptibility to IPM activities.

Potential Hurdles:

- Scaling of evaluated technologies to use in field trials.
- A limited number of waterguns are available and replacement parts are similarly in limited supply.
- Obtaining needed permits/access to conduct field trials.

28. Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp

Lead Agency: USGS (Upper Mississippi Environmental Science Center; Illinois Water Science Center and Indiana Water Science Center)

Agency Collaboration: Western Illinois University

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$150,000	$0

Project Description: Asian carp are invasive species originating from eastern Asia. They were first introduced to the southern United States in the 1970s as potential control agents for algae in ponds used for aquaculture. Subsequent escape into the wild has resulted in the establishment of invasive populations in southeastern and central regions of the United States. The fish are now poised to invade and potentially establish harmful populations in other ecologically important systems, including the Great Lakes, upper reaches of the Mississippi and Ohio Rivers, and other interior rivers, lakes, and reservoirs in the Midwest. In efforts to keep Asian carp from establishing populations in other ecologically important systems and control Asian carp where they are already established, the USGS and other collaborators are conducting ecological studies on established and emerging populations.

Advanced telemetry technologies have emerged that have great potential to inform control and containment efforts underway in the Illinois River and elsewhere. For example, the USGS in Indiana through previous GLRI support has developed techniques to detect wild Asian carp (*Hypophthalmichthys* spp.) that have been surgically radio tagged by university researchers through a system that integrates commercially available telemetry detectors and temperature sensors into several existing USGS streamflow gage sites. The result facilitates the following:

1. Real-time, hourly reporting of total detections and total counts of individual tagged Asian carp through the USGS National Water Information System internet interface (example of site at: http://waterdata.usgs.gov/in/nwis/uv?site_no=03323500)
2. Individual e-mail and mobile phone notifications when total Bighead and Silver Carp detections and counts exceed a user-set threshold can be sent through the existing USGS Water Alert system (http://water.usgs.gov/wateralert/).
3. Acquisition, download, and analysis of data on detections of tagged individual Asian carp by researchers and state and federal managers is accelerated through periodic remote, cellular-modem based data downloads from data loggers at the gage site.

Asian carp data from the USGS real-time sites would accelerate GLRI and state-sponsored efforts to respond to and explain adult Asian carp movement events in the Illinois River watershed toward control measures that separate them from the Great Lakes. The data would augment existing collection of quality assurance information on Asian carp presence from USGS and other use and validation testing of emerging rapid eDNA and microbial tracking methods of detecting Asian carp. In addition, real-time sites provide the future capability to integrate the data with emerging USGS capability to process and present Asian carp movement information using GIS-based tools.

28. Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp

USGS will procure, install, and operate for up to 3 years, (1) three to four automated receivers at or near existing USGS streamgage sites in the Illinois River Basin to monitor and transmit real-time data on the movements of acoustically tagged Asian carp, and (2) temperature sensors at these sites to indicate thermal conditions favorable to Asian carp migration. Installation of USGS real-time detectors of acoustically tagged Asian carp at USGS stream gages in the Illinois River Basin will enable real-time streamflow data to be evaluated in connection with Asian carp detection. Detection data from the real-time sites will be reported on-line at approximately 1- to 4-hour intervals through the existing USGS National Water Information System NWIS-WEB system (http://waterdata.usgs.gov/in/nwis/rt) and archived in that system.

Geolocator tags are another advanced telemetry technology with potential application in the efforts to control and contain Asian carp by providing reliable and easier to obtain (as compared with traditional manual tracking telemetry) location data to assess movement and habitat use at fine temporal and spatial scales. This technology integrates GPS satellite capabilities into standard-sized telemetry tags providing the potential to obtain continuous location data on Bighead and Silver Carp with accuracies of 15 to 75 m. This technology relies on a tethered or direct-attach tag that is capable of downloading positional satellite information to pinpoint the fish. For initial feasibility testing, researchers from Western Illinois University will use tags that store positional information from satellites and allow tracking and data download via VHF radio. Final tag design will allow downloads via Argos satellite and eliminate the need for manual tracking to recover stored positional data. This technology would allow for satellite to Internet interface for real-time tracking of Bighead and Silver Carp. The initial VHF tags will be evaluated in closed ponds or raceways in fall 2015 to determine the best method for attaching tags to the fish, tag accuracy, transmission efficiency, tag retention, and feasibility of tag recovery. After tag capabilities and attachment methods have been tested and optimized in pond studies, researchers will conduct field trials with 10 to12 VHF tags at Hanson material services in the Marseilles reach of the Illinois River in fall 2015 or spring 2016 (dependent on tag procurement and delivery schedules). Bighead and Silver Carp will be captured and implanted with tags and released. After several weeks, the fish will be manually tracked using VHF radio tracking equipment to recover stored data. Following download attempts, efforts will be made by commercial fishers to capture tagged fish to recover tags for reuse. Following VHF tag testing, a field deployment of an Argos-capable version of these tags will be conducted in 2016 to evaluate their capabilities for tracking Bighead and Silver Carp. If all testing phases are successful, researchers from Western Illinois University will conduct a larger deployment of this technology to collect habitat and movement data on Bighead and Silver Carp tagged in the upper reaches of the Illinois River from Peoria Pool through Dresden Pool.

FY 2015 Actions:

- After funds are allocated to the project, USGS will procure, install, and operate for 2 to 3 years, (1) three automated receivers at or near existing USGS streamgage sites in the Illinois River Basin to monitor and transmit real-time data on the movements of acoustically tagged Asian carp, and (2) temperature sensors at these sites to indicate thermal conditions favorable to Asian carp migration.
- Identify USGS stream gage sites for upgraded real-time capability to detect tagged Asian Carp in consultation with university researchers and state and federal agencies that deployed the tagged fish.

- Procure hydrophones, software, and related supplies.
- Install and implement upgraded real-time capability to detect and report data on tagged Asian Carp at least one of the sites.
- Quality assure system operation off line for up to 3 months before full rollout to open USGS system.
- After funds are allocated, Western Illinois University will procure and begin pond and field testing of geolocator tags on Bighead and Silver Carp.
- Complete closed-system evaluation of tag accuracy, VHF capabilities, and optimize tag attachment design.
- Complete initial field evaluation 10 geolocator tags to at Hanson Materials backwater to monitor Bighead and Silver Carp movement and test feasibility of tag recovery.

FY 2016 Actions:

Automated receivers at or near existing USGS stream gage sites

- Install and implement upgraded real-time capability to detect and report data on tagged Asian Carp at remaining sites.
- Continue offline quality assurance of system operation for up to 3 months at new sites, as needed before full release to open USGS system.
- Implement full release to open USGS system.
- Develop GIS methods to aggregate to process and periodically report Asian carp movement information to researchers and managers.
- Report on system development and results through the scientific literature and at a widely attended regional scientific and resource management meeting.

Geolocator tags

- Field test GPS tags capable of real-time tracking and determine their effectiveness and efficiency in the Upper Mississippi River.
- Redeploy and monitor tags after recovery and recharging.

Expected Milestones (FY 2015-16):

Automated receivers at or near existing USGS stream gage sites

- Project start for the real-time monitoring activity is assumed to be August 2015; 1 to 4 months from project start.
- Locate gage sites for installation in consultation with natural resource managers and researchers.
- Procure stationary receivers and necessary cables, data loggers and cellular modems. Data loggers, many cables and temperature probes can be procured through existing USGS contracts. Stationary receivers and dedicated cables will require a dedicated purchase. 5 to 6 months from start (about February 2016).
- Install access points from bridges. Deploy passive monitors and temperature probes. Transmit data real-time to USGS NWIS system. Post temperature data on-line. Have detections retrievable to researchers from dedicated IP access at their duty stations. 6 to 12 months from project start. Monitor data through duration of planned USGS and Western Illinois University collaborations.

Geolocator tags

- Complete pond and field testing of tags to determine the efficacy of GPS tags to track Bighead and Silver Carp in the Upper Illinois River.

Outcomes/Output:

Automated receivers at or near existing USGS stream gage sites

- Improve interagency and university researcher response to Asian carp movements in the Illinois River relative to existing and planned barriers.
- Accelerate emergency response by the IL DNR and others to Asian carp migration toward existing controls at the time of a high flow event or large-scale fish movement. Currently deployed downloadable stationary and manual receivers operated by others will not provide information about whether tagged Asian carp decides to rapidly migrate upstream toward controls possibly until weeks after the event.
- USGS real-time monitoring will assist response by researchers and managers to spawning events in the Illinois River basin.
- Improve Define the ability of a CO_2 barrier, when deployed in the field at real-world scales, to impede the movement of free-swimming Asian carp.
- Recommendations to management agencies on the operating conditions to establish a static deterrent barrier.

Geolocator tags

- Determine tag design and attachment for optimum retention on Bighead and Silver Carp.
- Define the efficacy of using GPS tags to monitor Bighead and Silver Carp movement in the Mississippi River Basin.
- Recommendations to management agencies on Bighead and Silver Carp movement, potential spawning and feeding areas, seasonal refugia, and challenging of barrier defenses in the Upper Illinois River.

Potential Hurdles:

Automated receivers at or near existing USGS stream gage sites

- Delays in funding availability beyond June 2015 could delay the acquisition and installation of the real-time detection equipment beyond the date range when data collection should start. Early allocation to the project of up to about $38,000 would permit acquisition of project equipment by the time when the rest of funds would be released and installation and operation could commence.

Geolocator tags

- Delays in funding, procurement and delivery of geolocator tags would result in commensurate delays in actions and milestones.
- GPS tags of this nature have not been tested on fishes within a freshwater, lotic system, and potential hurdles may exist in tag retention and recovery. Bighead Carp and Silver Carp often have a propensity for wetted snags, which may affect tag retention and entanglement. Failure to recover the initial tags will result in a loss of data for the animal which is why the VHF transmission is critical for recovering a fish or severed tag.

29. Control Technologies at Starved Rock

Lead Agency: USGS

Agency Collaboration: IL DNR, USACE, USFWS, and Southern Illinois University

Funding Table:

Funding	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$200,000	$0

Project Description: Minimizing propagule pressure is a key objective or first principal in minimizing the establishment of invasive species in new areas. Further enhancing the barrier characteristics of the "high-head" dams in the upper Illinois River dams via BMPs of gate and lock operations, and deterrents in lock chambers would add another measure of protection against Asian carp invasion into the Great Lakes. These practices and deterrents (e.g., if sound was effective) might come at relatively low cost (installation and operation) and be implementable in relatively short timeframes. Enhancing barrier-characteristics via BMP and relatively low cost deterrents could also be implemented at Brandon Road until the more comprehensive deliberate barrier is complete.

Currently, the electrical barriers located in the CAWS near Romeoville, Illinois are the only deliberate barriers in the Illinois River to keep Asian carp from moving from the Mississippi watershed into the Great Lakes. Additional deliberate barriers are being considered including at Brandon Road Lock and Dam to provide redundancy to the electrical barriers in the CAWS. Brandon Road Lock and Dam makes tactical sense as a barrier because of its strategic location and existing barrier characteristics (i.e., relatively high head and controlled gate and lock operations). Designing and installing comprehensive barriers like Brandon Road and the electrical barriers in the CAWs cost tens of millions of dollars and take years to complete. Further, annual operating costs in the form of electricity and personnel for these deliberate barriers run in the millions of dollars and make large numbers of them cost prohibitive.

Below the electrical barrier are four other (in addition to Brandon Road) relatively "high-head" navigation dams including Starved Rock, Marseilles, Dresden, and Lock Port. Evidence in the form of continued low abundance of Asian carp in the navigation pools above Starved Rock dam suggests that these other high-head dams in the upper Illinois River might be acting as partial barriers to Asian carp because of their design (i.e., gated, with relatively high head). Further, there has been no evidence of reproduction in the reaches above Starved Rock dam suggesting that the river below Starved Rock dam might be the only source of adult Asian carp in the reaches above that dam. The design of these dams might generally limit Asian carp passage (1) to times when gates are open or submerged during high discharge events or (2) via lock chambers. If the barrier characteristics of these high-head dams under various hydrologic conditions and seasons can be better understood and enhanced with low cost measures, then the number of Asian carp present available to challenge the more comprehensive barriers would be reduced. This in turn would reduce the likelihood of Asian carp getting into the Great Lakes to act as propagules.

29. Control Technologies at Starved Rock

To determine if these dams act as barriers and if barrier-characteristics of these dams can be enhanced, we will use reach-specific hydrologic data, dam-specific design and operations data, and existing telemetry data (SIU) on Asian carp dam passage to assess under what conditions and how Asian carp are passing through these dams. Alongside or following this assessment, we will begin to study whether a combination of best management practices at locks and acoustic deterrents in the approach channel to or in locks can deter Asian carp from entering or using the lock chamber. Field experience (i.e., Silver Carp jumping in response to boat motors and both Bighead and Silver Carp fleeing areas being disturbed by fishers) and controlled experiments suggest that sound is effective at driving Asian carp out of areas. The assessment of BMPs and a sound deterrent in the approach channel or lock chamber will be conducted at Starved Rock Dam (most downstream high-head dam). Experimental field studies will be conducted on site to assess the effectiveness of sound and BMPs at keeping Asian carp out of approach or lock chambers under simulated lockage scenarios. These studies will deploy traditional and acoustic sampling techniques, and telemetry, at appropriate seasons and discharges (as suggested by existing Asian carp passage data) to meet study objectives.

FY 2015 Actions:

- Form and meet with a collaborative to vet study designs and approaches.
- Assign and hire appropriate personnel.
- Assemble hydrologic, metrological, and telemetry data into analyzable data set and initiate analysis (hazard-type analysis; Zigler et al.) to determine conditions that deter or permit Asian carp passage though high-head dams on the upper Illinois River.
- Determine standard practices for locking vessels upstream through dams.

FY 2016 Actions:

- Report on analysis of Asian carp passage in relation to hydrologic and meteorological conditions.
- Initiate experimental field studies to determine the behavior of Asian carp to (1) standard lockage procedures and (2) the deployment of acoustic deterrents in approach channels and lock chambers under simulated lockage scenarios.

Expected Milestones:

- Better understanding of the existing barrier-characteristics of high-head dams on the upper Illinois River and its relationship to the Asian carp life cycle.
- Potential ways to enhance the barrier-characteristics of these high-head dams using BMPs and acoustic deterrents.

29. Control Technologies at Starved Rock

Outcomes/Output:

- If the source of the Asian carp in the upper Illinois River is from upstream migration rather than reproduction as evidence suggests and the barrier-characteristics of these high-head dams can be enhanced with BMPs and acoustic deterrents then the overall numbers of adult Asian carp will be reduced. A reduction in abundance of Asian carp in this reach via reduced movement through high-head dams and harvest via contracted fishing will equate to reduced likelihood of challenges to the existing and planned deliberate barriers. This reduced likelihood of challenges to the deliberate barriers would result in commensurate decreased likelihood of Asian carp propagules in the Great Lakes.
- Reduced Asian carp abundance in the upper Illinois River will also likely act to reduce the chance of successful reproduction in this reach to act as another source of adult Asian carp available to challenge the deliberate barriers.

Potential Hurdles:

- N/A.

30. Enhance Monitoring through CAWS Pathway

Lead Agency: IL DNR

Agency Collaboration: IL DNR, USACE, and USFWS worked continually and extensively on the creation of the MRP and monitoring efforts and plans.

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$1,950,000	$0

Project Explanation: Work will include a continuation of extensive monitoring efforts in elevated risk areas to detect the presence of Asian carp and remove them, as necessary. These areas are those previously identified through waterway characterization as preferable Asian carp habitat, extensive sampling, or where previous eDNA sampling indicated the presence and persistence of Asian carp DNA in the area at the time of sample collection. Monitoring of these elevated areas will include the following:

- Evaluation and updates to enhanced eDNA testing and monitoring in the CAWS.
- Conventional monitoring, such as electrofishing and netting, at designated areas.
- Continued deployment of gears developed through prior gear development project
- Continued support of multi-year MRP (2014-2016) through enhanced monitoring.
- Continued emphasis on larval and small fish in upper IWW, Des Plaines River, and CAWS to assess risk of small fish testing barrier, to inform barrier operations, and continually evaluate barrier efficacy.
- Ongoing monitoring of evaluation and efficacy. (Analysis of upstream commercial removal efforts and population front, independent review of efforts, and identification of needs.)
- Based upon detection probability analysis and extensive monitoring, we are able to re-focus monitoring efforts downstream of electrical barrier system to maximize information gained for prevention of Asian carp challenging CAWS, barriers, and ultimately Lake Michigan.
- Focused sampling seasonally in CAWS based upon detection probabilities allows for heighted awareness directly downstream of electrical barrier system.
- Continue to statistically evaluate monitoring program and evaluate for efficiencies in program, gears, and coordination of efforts.
- Specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement, in part identified in the GLMRIS and support decision making processes in developments of alternative and/or additional measures. These efforts will include:
    - Telemetry efforts
    - Floy tagging efforts
    - Hydroacoustic/side scan sonar efforts
    - Traditional and contracted monitoring efforts
- Weekly coordination and summaries of scheduled activities on the waterway.
- Monthly data summaries as available from MRP activities.

- Coordination with MRWG.
- Continue field support for removal efforts of any identified bighead carps in urban fishing ponds (a likely historical relic of fish rearing practices).
- Continue to build incident management scenarios to support response exercises, capacity, and communication to further prevent establishment of Asian carp in the Great Lakes.
- Support ACRCC and MRWG efforts, outreach and communication of results to partners and interested parties.
- Lead role in development/updates of multiyear MRP based on results and findings of ongoing efforts as necessary.

Summary of Actions to Date:

Fixed Site Monitoring Upstream of the Dispersal Barrier – This part of the project included standardized monitoring with pulsed-DC electrofishing gear and contracted commercial fishers at fixed and random sites in the CAWS upstream of the Dispersal Barrier.

- Estimated over 12,030 person-hours spent sampling at fixed sites upstream of the Electric Dispersal Barrier in 2010 – 2013.
- 636.5 hours spent electrofishing and 420 km (261.1 miles) of trammel/gill net deployed at fixed sites in 2010 – 2013 and random areas in 2012 – 2013.
- Sampled 227,181 fish representing 72 species and two hybrid groups during electrofishing and trammel/gill netting at fixed sites in 2010 – 2013 and random sites in 2012 – 2013.
- 103.5 hours spent electrofishing and 153.2 km (95.2 miles) of trammel/gill net deployed at fixed sites and random areas in 2013.
- Sampled 34,418 fish representing 57 species and two hybrid groups during fixed and random electrofishing and trammel/gill netting in 2013.
- No Bighead Carp or Silver Carp captured or observed during fixed site and random area electrofishing and netting in 2013.

Fixed Site Monitoring Downstream of the Dispersal Barrier – This part of the project included monthly standardized monitoring with pulsed-DC electrofishing gear and contracted commercial fishers at four fixed sites downstream of the Dispersal Barrier in Lockport pool and downstream from the Lockport, Brandon Road, and Dresden Island locks and dams. It provides information on the location of the Asian carp detectable population front and upstream progression of populations over time.

- Estimated 7696.5 person-hours spent sampling at fixed, random, and additional sites and netting locations downstream of the Electric Dispersal Barrier from 2010-2013.
- 222.5 hours spent electrofishing and 236 km (146.7 miles) of trammel/gill net deployed.
- Sampled 105,466 fish, representing 92 species and seven hybrid groups.
- No Bighead Carp or Silver Carp were captured by electrofishing or netting in Lockport and Brandon Road pools.
- Thirty Bighead Carp and two Silver Carp were collected in the Dresden Island pool during fixed, random, and additional commercial netting from 2010-2013.
- One Bighead Carp and no Silver Carp were captured at Dresden Island pool while electrofishing from 2010-2013.

- Eighteen Bighead Carp and 293 Silver Carp were captured by electrofishing in Marseilles pool from 2010-2013.
- Detectable population front of mostly Bighead Carp located just north of I-55 Bridge at river mile 280 (76 km (47 miles) from Lake Michigan). No appreciable change in upstream location of the population front in past seven years.

Asian carp spawning activity was observed on 22 May 2013 in the Marseilles pool. However, Asian carp larvae and juveniles were not detected upstream of Peoria pool or less than 161 km (100 miles) downstream of the electric barrier system and 220 km (137 miles) from Lake Michigan.

Young-of-Year and Juvenile Asian Carp Monitoring – This part of the project consists of monitoring for the presence of young-of-year Asian carp in the Illinois River, Des Plaines River, and CAWS occurred through sampling planned by other projects in the MRRP and targeted a segment of the Asian carp population typically missed with adult sampling gears.

- Sampled for young Asian carp from 2010 to 2013 throughout the CAWS, Des Plaines River, and Illinois River between river miles 83 and 334 by incorporating sampling from several existing monitoring projects.
- Sampled with active gears (pulsed DC electrofishing, small mesh purse seine, and beach seine) and passive gears (small mesh gill nets, mini-fyke nets, and pound nets) in 2013.
- Completed 1,107 hours of electrofishing across all years and sites.
- Examined 102,590 Gizzard Shad <152 mm (6 in) long in the CAWS and Illinois Waterway upstream of Starved Rock Lock and Dam and found no young Asian carp.
- Low catches of young Asian carp at all sites suggested poor recruitment years.
- Farthest upstream catch was a post larval Asian carp in the Peoria pool near Henry, Illinois (river mile 190) in 2012, over 100 downstream from the electric dispersal barrier.

Response Actions in the CAWS – This part of the project uses a threshold framework to support decisions for response actions to remove any Asian carp from the CAWS upstream of the Dispersal Barrier with conventional gear or rotenone.

- No Response actions in 2013.
- Completed three planned intensive surveillance events with conventional gears in the CAWS upstream of the Electric Dispersal Barrier and collected eDNA samples during 2013.
- Results from "*Planned Intensive Surveillance in the CAWS*" and "*Strategy for eDNA Monitoring*" are located in their respective sections.

Planned Intensive Surveillance in the CAWS – This part of the project represents a modification to response actions in the CAWS and surveillance events will target areas that have been previously monitored through response actions. These efforts will have the benefit of advanced planning and will be in locations where the repeated detection of eDNA in previous years indicates the potential presence of Asian carp in the waterway.

- Completed three planned intensive surveillance events with conventional gears in the CAWS upstream of the Electric Dispersal Barrier during 2013.

- Estimated 1,165 person-hours were spent to complete 45.8 hours of electrofishing, set 14.6 km (9.1 miles) of trammel/gill net and 1.1 km (0.7 miles) of deep water gill net, make three 800-yd (732 m) long commercial seine hauls, and deploy three tandem trap nets and eight hoop nets equal to 25.2 net-days of effort.
- Across all response actions and gears, sampled 22,896 fish representing 50 species and 3 hybrid groups.
- Examined 4,757 YOY Gizzard Shad and found no Asian carp YOY.
- No Bighead Carp or Silver Carp were captured or observed during response actions.

Barrier Maintenance Fish Suppression – This part of the project provides a fish suppression plan to support US Army Corps of Engineers maintenance operations and outages at the Dispersal Barrier. The plan includes fish sampling to detect juvenile or adult Asian carp presence in the Lockport pool downstream of the barrier, surveillance of the barrier zone with split-beam hydroacoustics, side-scan sonar and DIDSON imaging sonar, and operations to clear fish from between barriers by mechanical or chemical means.

- Multiple agencies and stakeholders cooperated in successfully removing fish between Barrier 1 and 2A for necessary barrier fish suppression on 3 separate operations. (June 17, August 26 to 27 and November 4)
- A total of 115 fish were removed using pulsed DC-electrofishing and 9 m (30 ft) deep gill nets, with 27 fish > 305 mm (12 in) in length.
- A total of 2 hours and 20 minutes of split-beam hydroacoustics and side-scan sonar where used to assess the success of the fish clearing operation by surveying the area in and near the barrier.
- No Asian carp were captured or observed during fish suppression operations.

FY 2015-16 Actions:

Fixed Site Monitoring Upstream of the Dispersal Barrier

These activities will continue in 2014-16 but in a reduced capacity. Seasonal Intensive Monitoring (as it will be called in the 2014-16 MRP) is a modified continuation of Fixed and Random Site Monitoring Upstream of the Dispersal Barrier and Planned Intensive Surveillance in the CAWS. A variety of gears will be used during seasonal intensive monitoring activities, including pulsed DC-electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets and Great Lake pound nets to capture and remove any Asian carp present in areas where eDNA has been found to accumulate. Sampling will occur both in Spring (June) and Fall (September) when carp catches in other areas are notably higher. Fixed and random sites throughout the CAWS above the electric barriers will be sampled at these times with electrofishing and contracted netting as in past years. Additional intensive monitoring with those gears and others listed above will occur: Lake Calumet will be sampled in the spring, and the North Shore channel in the fall.

30. Enhance Monitoring through CAWS Pathway

Fixed Site Monitoring Downstream of the Electric Dispersal Barrier

Fixed and random electrofishing and contracted netting was increased in 2014 below the Electric Barrier System. This was facilitated by a reduction in fixed and random electrofishing and contracted netting above the barriers. The sample design includes intensive electrofishing and netting at four fixed sites and will increase from four to 12 random sites in each of the four pools below the Dispersal Barrier (Figure 6). Fixed and random site electrofishing will take place bi-weekly from March through November. Contracted commercial netting will take place bi-weekly from March through December, except during June and September, and will include four fixed sites and 13, 13, and 24 random sites in the Lockport, Brandon Road, and Dresden Island pools, respectively. Contracted commercial netting in the Marseilles pool will occur at four fixed sites and four random sites. Effort in the Marseilles pool will remain the same as effort in 2013, to better evaluate the leading edge of the Asian carp population front in the Dresden Island Pool.

Young-of-Year and Juvenile Asian Carp Monitoring

As in the past, 2015-2016 sampling for young-of-year and juvenile Asian carp will take place through netting and electrofishing operations in this and additional projects. These projects included are Larval Fish and Productivity Monitoring, Fixed and Random Site Monitoring Upstream of the Dispersal Barrier, Fixed Site Monitoring Downstream of the Dispersal Barrier, Gear Efficiency and Detection Probability Study, Rapid Response Actions in the CAWS, Seasonal Intensive monitoring, Barrier Maintenance Fish Suppression Project, and the Des Plaines River and Overflow Monitoring Project. The collection of small fish in the Upper Illinois Waterway would suggest an increased risk of Asian carp movement toward Lake Michigan and this remains one of the primary foci of monitoring.

Response Actions in the CAWS

A decision tree is described in prior MRP's and we are prepared to use conventional gears, experimental gears and/or rotenone to capture and remove Asian carp from the CAWS upstream of Lockport Lock and Power Station as information and remedy suggest. Each response action will be unique to location, perceived severity of the threat, and likelihood of successfully capturing, removing, or stopping Asian carp. Response actions can use Agency and contracted netters for initial responses.

IL DNR contracts with a small set of commercial fishing crews as responders. These responders will fish during Seasonal Intensive Monitoring events, but also can be deployed to maximize removal efforts with any of the commercial tools, including seines up to ¾ mile long as IL DNR directs and is prudent and practicable (outlined in 2013 MRP and subsequent plans). Detection and response efficiency is important for appropriate and effective invasive species control. Exercises to increase or improve upon responses in challenging, multijurisdictional areas will be identified where appropriate to facilitate future response capacities and partnerships.

Barrier Maintenance Fish Suppression

The IL DNR will work with federal and local partners to remove fish >12 inches long between Barrier 2A and 2B before maintenance operations are initiated by collecting or driving fish into the net or from the area with mechanical technologies (surface noise, surface pulsed DC-electrofishing and surface to bottom gill nets) or, if needed, a small-scale rotenone action; and assess the success of fish clearing operations by surveying the area between Barrier 2A and 2B

with remote sensing gear (split-beam hydroacoustics and side-scan sonar). Success is defined as no fish >12 inches long in the between-barrier area, as determined with remote sensing gear or MRWG deems the remaining fish in the barrier as a low risk.

Communication and Framework Support

Coordination of response actions, reporting, technical support is needed when multi-agencies are acting together. Contracted personnel will assist with facilitation of framework objectives and Mentoring and Response needs that cannot be handled by any one agency directly or those items that will require facilitation:

- Updates program documents
- Supplementary Document Development
- Support Related Meetings
- Facilitate Public Meetings
- Incident Command System Training and Exercises

Expected Milestones:

Throughout 2015	Evaluation of threat in CAWS both above and below the electric barrier system.
Throughout 2015	Maintain high level of surveillance and increase efficiency and information from surveillance efforts.
Throughout 2015	Contract commercial fishing surveillance in the CAWS both above and below the electric barrier system.
Throughout 2015	Application of new gear into surveillance as warranted.
Throughout 2015	Monthly reporting of monitoring results to Asiancarp.us and informing ACRCC partners.
Throughout 2015	MRWG meeting to share and communicate significant findings as well as identifying needs to modify or update current monitoring plans as needed.

Support and facilitate Framework development and implementation.

Outcomes/Output:

- Prevention of Asian carp establishment in CAWS through an active and adaptive monitoring and management program.
- Coordination and summary of sampling and response efforts.
- Share expertise and lessons learned with other agencies and programs wanting to remove/control aquatic nuisance species.

Potential Hurdles:

- Unidentified pathways for expansion of Asian carp.
- Very large system to find very rare fish.
- Changes in population dynamics (significant increases in abundances of Asian carp moving close to or toward the barrier; or presence of small (< 4 inch) Asian carp in the vicinity of the barrier would challenge ability of current plan to further restrict lakeward movement of Asian carp populations (would need to implement additional or other control techniques).

31. Illinois River Stock Assessment/Management

Lead Agency: IL DNR

Agency Collaboration: Southern Illinois University, Feeding Illinois

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$300,000	$0

Project Explanation: IL DNR will advance its work monitoring and developing insights into the strategies for addressing Asian carp in the Illinois River. The primary objective is to understand population dynamics of Asian carp that would give insight into ability of directed harvest and other control measures to reduce overall populations within waters connecting to the Great Lakes and reduce movement of Asian carp upstream toward the CAWS. Population-level effects and capabilities of harvest as a control strategy are outlined in the Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States. Using best science and understanding the harvest and stock/recruitment variables in the upper Illinois River, IL DNR is further developing dynamic models to forecast and predict effects of harvest, other control efforts, and breadth of Asian carp populations. This investigation will provide science-based direction for harvest and control strategies and regional regulatory oversight to achieve goals for (1) prevention of spread toward the CAWS, and (2) further reduction of Asian carp populations. This project encompasses multiple studies with the goal of determining estimates of Asian carp abundance, biomass, size structure, demographics (such as growth and mortality), natal origin, and rates of hybridization in the Alton, LaGrange, Peoria, Starved Rock, Marseilles, Dresden Island, and Brandon Road pools of the Illinois and Des Plaines Rivers.

As with other projects, beginning in 2014 the project will specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement as noted in prior years' work, and in part identified in the GLMRIS, and support decision making processes in developments of alternative and additional measures.

Summary of Actions to Date: *Current notable points (Details in chapters of full annual and interim report found in 2013 Interim Summary Report, a product of the MRWG at www.asiancarp.us):*

Demographics in the Illinois River (Chapter 1)

- CPE estimates in late summer 2013 suggest that densities of Asian carp are lower than in 2011 and 2012. Apparent densities are highest in Peoria Pool. This change may be the result of the large amount of shallow-water areas and higher catch rates rather than actual density in this reach.
- Significant recruitment leading to a strong year class was not detected for over 6 years.
- Sampling in the lower reaches revealed some production of age-0 Asian carp in 2013.
- In 2013, the predominant "2008" year-class declined.

31. Illinois River Stock Assessment/Management

Sampling and Demographics (Chapter 1)

- Sampling is a continuation of 2011 sampling. Fixed locations were sampled in late summer 2012 and 2013. Used electrofishing and trammel nets.
- 36 fish species were encountered.
- Catch per unit effort of Asian carp declined during 2011 through 2013 in the two lower reaches. Peoria Pool did not change.
- In 2013, age-0 Asian carp were sampled in the lower reaches.
- Age distributions of Asian carp from the lower three reaches show no recruitment and declining older fish.
- Sex ratio did not deviate from 1:1 in 2013, although it was skewed toward males in 2012.

Hybridization (Chapter 1)

- 394 putative Asian carp were genotyped in 2012.
- Of these fish, 196 were pure Silver Carp, four were pure Bighead Carp; the rest were hybrids.

Harvest in Upper Illinois River (Chapter 2)

- Deployed jaw tags (N=276) in the Hanson Materials Service (HMS) east and west pits.
- 16,025 Asian carp were harvested from the HMS in 2013. Return rate of tagged fish declined through time.
- Modeling using recapture rates of Asian carp revealed that harvest in the HMS is very effective, contributing to mortality of nearly 100 percent. However, fish density increased during both years and tag return declined, suggesting net immigration into the backwater.

Movement (Chapter 3)

- In 2012, 372 Asian carp were implanted with acoustic transmitters.
- In 2013, 337 Asian carp were implanted with acoustic transmitters.
- Fish tagged were captured and released at the same locations. Fish were distributed from Dresden Pool to the Mississippi River. Thirty-eight Asian carp were caught and tagged in Dresden Pool, the farthest location for tagging Asian carp to date.
- Acoustic receiver network was expanded, particularly in the pools above Starved Rock Lock and Dam. Thirty-six receivers are maintained by SIU Carbondale. Receivers are now present in all lock chambers of the Illinois River to assess differential movement through locks versus gates. Re-detection of fish on receivers was about 30 percent.
- In 2010 and 2011, flooding in the Illinois River led to a 30 percent immigration rate of Asian carp from the Mississippi River. With the low water in 2012, average immigration dropped to 8.1 percent.
- Net movement of Asian carp was downstream in 2012 and 2013.
- Spawning behavior of Asian carp was quantified by IL DNR personnel in Marseilles Pool. These events corresponded with movements of Asian carp out of the HMS with elevated main-channel discharge.

Acoustics (Chapter 4)

- Acoustics conducted during 2010 through 2011 provided a conservation estimate for the three lower reaches of the Illinois River (main channel only with downlooking hydroacoustics only); 1,413 metric tonnes were estimated. Asian carp comprised greater than 60 percent of biomass.
- During 2012 through 2013, we have completed surveys from Dresden down to the confluence; this approach allowed us to get into the backwaters. We used 70 plus 200 kHz, side-looking transducers.
- 2012 – 2,306 miles of survey were completed.
- 2013 – 2,029 miles of survey were completed.
- Analysis is ongoing. We will be able to compare with CPE and determine whether there is a correlation between the two.

Recruitment Sources — Otolith microchemistry (Chapter 5)

- Water chemistry data continue to indicate that Sr:Ca is consistently higher in the middle Mississippi and Missouri rivers compared with the Illinois River, thus enabling use of this marker as an indicator of fish that have immigrated into the Illinois River from these other rivers.
- Using otolith core Sr:Ca data, we estimated that 28 to 53 percent of adult Silver Carp and 26 to 48 percent of hybrids in the Illinois River were immigrants that originated in the middle Mississippi or Missouri Rivers.
- Only 5 percent of the fish analyzed had otolith core $\delta^{18}O$ and $\delta^{13}C$ signatures indicative of use of floodplain lake habitats during early life, consistent with data from prior years.
- Among Silver Carp and hybrids that were immigrants to the Illinois River, the vast majority originated in the middle Mississippi River; only 2 to 8 percent of the total number of Silver Carp and hybrids captured in the Illinois River originated in the Missouri River.
- In contrast to Silver Carp and hybrids, otolith core Sr:Ca indicated that 91 to 98 percent of Bighead Carp analyzed originated in the Illinois River, with 2 percent originating in the middle Mississippi River, consistent with data from prior years.

Ecosystem Responses (Chapter 6)

- Reduction of Asian carp through controlled commercial fishing did not significantly influence zooplankton densities, gizzard shad relative weight, or gizzard shad catch-per-unit effort.
- Rotifers are proportionally dominant in terms of abundance in both upper and lower river sections.
    - Rotifers tended to be more abundant in the lower section when compared with the upper section.
    - Cladocerans tended to be more abundant in the upper section when compared with the lower section.
- Primary productivity (chlorophyll-*a* concentration) decreased from downstream to upstream.
- Total phosphorus (mg/L) decreased from upstream to downstream.

31. Illinois River Stock Assessment/Management

Modeling (Chapter 7)

- A paper on population responses of Asian carp to harvest is now published in *Fisheries* magazine.
- In 2013, we convened a group of modeling experts in fish ecology. This group provided an outline for a spatially explicit model of movement of Asian carp as a function of density, demographics, and environmental conditions.
- This model is currently in development.

FY 2015-2016 Actions:

- Gather and share (communicate) basic information regarding ongoing market-driven economy, industry developments, and carp populations to decision makers and managers to understand existing effort to prevent upstream migration and to facilitate information of ongoing efforts to the public sector (2014 to 2015).
- Although data processing is ongoing, Asian carp abundance appears to be at a low level in 2012 and 2013. Poor recruitment and natural mortality, perhaps coupled with harvest, contribute to this pattern in Upper Illinois River. Evaluation of these data throughout 2014 and 2016 will highlight areas in need of further targeted efforts to further the goal of contracting population of fish away from sensitive areas or pathways toward Lake Michigan.
- Specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement, in part identified in the GLMRIS, and support decision making processes in development of alternative and additional measures. These efforts will include:
    - Telemetry efforts
    - Hydroacoustic/side scan sonar efforts
    - Traditional and contracted monitoring efforts

  Information from these efforts can inform harvest strategies and inform managers on potential for infrastructure modification, operations, or design at or near lock chambers or other locations where fish may by-passing bottlenecks.

Expected Milestones:

- Population estimate for all Illinois populations of Asian carp for use by program to maximize efficiency in reducing numbers and retracting range of Asian carp.
- Dynamic movement and multi-pool models for entire Illinois River.
- Identify areas of control.
- Identify areas to restrict fish passage.

Outcomes/Output:

- Ability to transfer knowledge, management actions, and control technologies obtained from Asian carp activities to national or international levels.
- Conveyance of information to the ACRCC regarding control efforts to reduce the density of Asian carp approaching the Great Lakes.
- Prediction of effects of harvest and other control efforts on movement of Asian carp populations toward the Great Lakes.

31. Illinois River Stock Assessment/Management

- Determination of potential impact of Asian carp on native fish and other ecosystem parameters if the carp invades the Great Lakes.
- Reduced upstream passage of Asian carp.
- Overall reduced populations of Asian carp in upper Illinois Waterway.
- Reduced risk of Asian carp at or near electric barrier system.

Potential Hurdles:

- Variation in feral carp populations caused by reproduction and movements may exceed ability to detect changes created by harvest and control efforts.
- Hydrological effects on removal efforts and implementation of surveillance.

32. Contract Fishing for Detection and Removal

Lead Agency: IL DNR

Agency Collaboration: USGS during Integrated Pest Management field trials

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$1,200,000	$0

Project Explanation: This program was established to reduce the numbers of Asian carp below the Electric Barrier System through controlled and contracted fishing efforts. Reducing the number of Asian carp below the Electric Barrier System will reduce the opportunity for carp to test the barrier and therefore decrease the possibility of Asian carp moving across the barrier and gaining access to waters upstream of the Barrier. Refocus of efforts in 2014 can further remove more fish from the Illinois River from the most populated reaches. This program also allows for monitoring population densities of Asian carp over time in the CAWS down to Starved Rock Pool.

Summary of Actions to date:

- Contracted commercial fishers and assisting IL DNR biologists deployed 1,585 km (985 miles) of net in the upper Illinois Waterway from 2010 to 2013.
- A total of 56,435 Bighead Carp, 94,071 Silver Carp, and 799 Grass Carp were removed by contracted netting. The total weight of Asian carp removed was 1006.72 tons (62.41 tons in 2010, 351.78 tons in 2011, 284.53 tons in 2012, and 308 tons in 2013).
- Identification of sink populations in the upper waterway facilitates removal.
- Carp populations have not significantly moved lakeward since 2006.

FY 2015 – 2016 Actions:

Barrier Defense Asian Carp Removal Project

This project uses contracted commercial fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines Rivers downstream of the Dispersal Barrier. Ten commercial fishers will be employed to harvest as many Asian carp as possible in the Starved Rock and Marseilles Pools. Harvested fish will be picked up and utilized by private industry for purposes other than human consumption and to gather information on Asian carp population abundance and movement in the IWW downstream of the Dispersal Barrier as a supplement to fixed site monitoring by contracted netters (2.1.1). In the CAWS (seasonally) and from barrier down to Dresden Island Pool (bi-weekly), many of the same contracted netters will work in teams of two to detect and remove Asian carp; these contactors also serve as responders (2.1.1).

32. Contract Fishing for Detection and Removal

Expected Milestones:

- Throughout 2015 to 2016 - Annual observance of reduction of biomass of Asian carp detected in river reaches below the Electric Barrier System, thus reducing the threat of challenges to Electric Barrier System and lower threat to Great Lakes.
- A minimum of 350 tons of Asian carp removed from upper IWW annually.
- Deploy seines to maximize removal at least twice annually.

Outcomes:

- Ability to assess these populations and adjust efforts to optimize impacts.
- Population reduction.
- Reduce opportunities for Asian carp to challenge electric barrier.
- Apply multiple control and detection techniques to maximize control on an invasive species.
- Monitor leading front of Asian carp length and weight and general biological condition.
- Have significant resources contracted for implementation over a short response time for rapid responses.
- Significant personnel with experience fishing multiple gears in riverine conditions to respond rapidly for early detection and rapid responses.
- Assessment of efficacy of removal efforts by reference to added telemetry data (other projects) is expected to indicate success of removal efforts on a pool-by-pool basis and thus success in prohibiting upstream movement of Asian carp.
- Additional removal using contracted netting (both seining and gill/trammel netting) possible with efficient deployment of fishers as informed by telemetry and remote sensing (concurrent projects with results communicated to fishers should improve removal rates).

Potential Hurdles:

- Increased immigration from out-populations could outpace removal efforts (being investigated by stock assessment, population estimates, and comparing catch rates).
- Removal efforts can be affected by weather and river levels. Effort will be scheduled to minimize these factors or rescheduled in case efforts need to be canceled for safety concerns.
- Without sufficient immigration and recruitment, removal efforts could drive population down without immigration (as designed), which could preclude removal of 350 tons annually. In this case, removal efforts can be optimized at new levels.

33. Interim and Long-Term Strategy and Tactics Development at Starved Rock

Lead Agency: IL DNR

Agency Collaboration: University of Illinois, SIU, USACE, USGS

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$100,000	$0

Project Explanation: Long-term success of keeping Asian carp from expanding into the Great Lakes basin will take a consistent and long-term action. Currently, the spread of Asian carp has stalled, affording more time for action; these actions should exploit bottlenecks that already exist to be most efficient and time sensitive to enforce. Several studies by Great Lakes Commission and USACE have suggested one of these bottlenecks may be Brandon Road Lock and Dam. To further inform control efforts, studies focused on this location and other potential bottlenecks (Starved Rock Lock and Dam and Lockport Lock and Dam) can expedite future actions.

Data have clearly shown the success of removal efforts; to further exacerbate the removal process, understanding times or methods to further prevent immigration to the upper IWW is prudent.

Current efforts are assessing the movement of Asian carp between pools on the Illinois River, including Starved Rock Lock and Dam (the gateway to the upper Illinois River). This location likely passes fish both through the water control structures and lock. This project would assess even further the micromovements of carp in this area as well as gleen data and understanding from USACE and USGS fish passage experts and publications. Stopping fish here, as well as at Brandon Road, can increase the efficacy of all the barriers, regardless of upstream position.

FY 2015-2016 Actions: Study is ongoing and will inform agencies on other specific, interim reports expected in 2015 to begin further informing agency on challenges of additional fish barrier or demonstrations at Brandon Road.

Outcomes/Output:

- Improved understanding of the efficacy of Starved Rock Lock and Dam structures within IWW to stop fish movement.
- Knowledge of the cost, feasibility, and logistic challenges associated with the use of Starved Rock Lock and Dam as a fish deterrent in a real-world scenario.
- Also evaluate and assess the non-target impacts of lock and dam barriers on biota, abiotic parameters, and existing infrastructure (existing cement locks) if alternative technologies are utilized (CO_2, water guns, daily operations, or other) to stop fish movement.
- Capturing tagged fishes that will inform on efficacy of existing structures to fish passage with information on species, size, and season of passage.

- Insights into fish staging locations around existing structures.
- Create a decision support framework that will gather needed fish and fish community information needed in evaluation of a long-term strategy to prevent carp passage.
- Interim measures Work group development to bring needed expertise into close communication with projects (will inform interim measures and long term solutions as identified by IL DNR, federal, state, and NGO studies, such as GLMRIS and GLC Divide proposals).

Potential Hurdles:

- Timely permitting and permission to allow technologies to be used as a deterrent in an ecologically important location (trials).
- Lack of appropriate data or information to inform on impacts.
- Tagging numbers need to be high; therefore, to augment telemetry, we will use external and numbered floy tags. Because fish with these tags must be recaptured, both the numbers of tags deployed and the effort to recapture them need to be significant. This study will rely on the increased monitoring efforts for recapture. If amount of fish passage is low, it could be unobserved, thus requiring even additional efforts (floy tags and telemetry) in future to fully understand.
- Permitting timelines could slow development of emerging technologies.
- Construction of physical needs takes time and weather/river-level dependent.
- Efficacy of potential mitigating strategies from fishing pressure, lock/dam operations, and seasonal timings will be evaluated for future use.

34. Interim and Long-Term Strategy and Tactics Development at Brandon Road

Lead Agency: IL DNR

Other Collaborators Involved: University of Illinois, SIU, USACE, USGS

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$0	$0

Project Explanation: Long-term success of keeping Asian carps from expanding into the Great Lakes basin will take a consistent and long-term action. Currently, the spread of Asian carps has stalled, affording more time for action; these actions should exploit bottlenecks that already exist to be most efficient and time sensitive to enforce. Several studies by GLC and USACE have suggested one of these bottlenecks may be Brandon Road Lock and Dam. To further inform control efforts, studies focused on this location and other potential bottlenecks (Starved Rock Lock and Dam and Lockport Lock and Dam) can expedite future actions.

Studies will focus initially on fish presence/movement (Asian carp and native fishes) around and through these structures. Blocking fish passage is a concern in fish management with removing structures even when invasive species exist, to allow the native fish habitat they would otherwise not have access to. The dilemma is that such a structure may be important in managing an Asian carp threat to the Great Lakes; thus, information on both nuisance species and native species behavior is necessary.

Further and additional studies are recognized for other biota, water quality effects of structures design, construction, and operation. IL DNR will seek support for needed data mining and studies to be conducted by Illinois agencies, research organizations, and contractors as needed to keep progressing in long-term solutions. Currently, these needs are not completely identified; thus, budgets for additional work will be highly collaborative with a proposed state-federal work group proposed to help manage these. Membership to be identified with the goals and expertise to accomplish project developments. Tagging and telemetry studies identified in other projects will further confirm the efficacy of these barriers. This study will evolve further as future directions become clear and may need to involve contractors to research additional needs.

FY 2015 to 2016 Actions: Study is ongoing and will inform agencies on other specific, interim reports expected in 2015 to begin further informing agency on challenges of additional fish barrier or demonstrations at Brandon Road.

Outcomes:

- Improved understanding of the efficacy of current lock and dam structures in Illinois Waterway to stop fish movement.

- Knowledge of the cost, feasibility, and logistic challenges associated with the use of locks and dams as a fish deterrent in a real-world scenario.
- Begin assessment of the non-target impacts of lock and dam barriers on biota, abiotic parameters, and existing infrastructure (existing cement locks) if alternative technologies are utilized (CO_2, water guns, or other) to stop fish movement.
- Capturing tagged fishes that will inform on the efficacy of existing structures to fish passage with information on species, size, and season of passage.
- Insights into fish staging locations around existing structures.
- Create a decision support framework that will gather needed fish and fish community information needed in evaluation of long-term strategy to prevent carp passage.
- Interim measures work group development to bring needed expertise into close communication with projects (will inform interim measures and long-term solutions as identified by IL DNR, federal, state, and NGO studies, such as GLMRIS and GLC Divide proposals).

Potential Hurdles:

- Timely permitting and permissions to allow technologies to be used as a deterrent in an ecologically important location (trials).
- Lack of appropriate data or information to inform on impacts.
- Tagging numbers need to be high; therefore, to augment telemetry, we will use external and numbered floy tags. Because fish with these tags must be recaptured, both the numbers of tags deployed and effort to recapture them need to be significant. This study will rely on the increased monitoring efforts for recapture. If amount of fish passage is low, it could be unobserved, thus requiring even additional efforts (floy tags and telemetry) in future to fully understand.
- Permitting timelines could slow development of emerging technologies.
- Construction of physical needs takes time and weather/river-level dependent.

35. Use of Improved Gear and Novel Designs at Brandon Road

Lead Agency: IL DNR

Agency Collaboration: None

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$150,000	$0

Project Explanation: Current research is evaluating netting and capture technologies that can capture or increase capture efficiencies within the CAWS or in specific habitats within the CAWS. A working group of net makers, fisheries biologists, Great Lakes and riverine commercial fishers, and hydro-acoustic and pheromone experts has developed several tools/items of gear to use in the CAWS and IWW. Deep panel gill nets, large hoop nets (6 feet), and Great Lakes-style pound nets are currently being evaluated as appropriate gears that may increase our ability to detect Asian carp in the CAWS and upper IWW. Additional locations and gear, as well as combination of gears and fine-tuning is ongoing to further increase detection rates of Asian carps. Pheromone research by cooperating agencies has identified some baits and lures that also may aid in capture of Asian carp; these tools may be implemented as available. Through these efforts, gears can be fine-tuned and recommended for full implementation and inclusion in response, removal, or monitoring efforts. In particular, downstream of Brandon Road Lock and Dam has been identified as a location where increased efforts should be focused. This project will assist in further customizing gear for this specific area as well as other areas to fully implement gear with highest efficiency throughout MRP areas, as appropriate. This may also replenish appropriate gear as needed to achieve MRP objectives.

Summary of Actions to Date:

Asian Carp Gear Efficiency and Detection Probability Study – This part of the project assessed efficiency and detection probability of gears currently used for Asian Carp monitoring for example, pulsed-DC electrofishing, gill nets, and trammel nets) and other potential gear (for example, mini-fyke nets, hoop nets, trap nets, seines, and cast nets) by sampling at ten sites in the Illinois River, lower Des Plaines River, and CAWS that have varying carp population densities. Results will inform decision-makers on appropriate levels of sampling effort and monitoring regimes and ultimately improve Asian Carp monitoring and control efforts.

- Pulsed-DC electrofishing was the most effective gear for capturing Silver Carp, whereas hoop nets were the most effective gear for capturing Bighead Carp. Hybrid Asian carp were vulnerable to both electrofishing and hoop nets.
- Hoop nets outperformed gill/trammel nets in experimental deployments at fixed sites. Gill and trammel nets have been seen to outperform hoop nets in MRP removal efforts, thus comparison of contracted netters and experimental deployments need further evaluation.

- Asian carp were most abundant in the LaGrange and Peoria pools; abundance declined at upstream sites and no Asian carp were observed upstream of the electrical barrier in the CAWS.
- No age-0 Asian carp were observed in 2013. Possible age-1 Asian carp (< 500 mm) were most abundant in the Peoria pool, but were relatively scarce elsewhere, suggesting populations consisting primarily of larger, older fish.
- Tributary sites were sampled with pulsed-DC electrofishing gear in the Spoon, Sangamon, Mackinaw, and Kankakee Rivers during 2013. No Asian carp were observed in the Kankakee (major tributary closest to the electric barrier system), whereas 513 Asian carp were captured from the other three tributaries.

Detection probabilities for Asian carp were lower at upstream sites than at downstream sites. Given the lowest estimates of detection probability for sites where Asian carp were captured, a minimum of 17 pulsed-DC electrofishing transects (15-minute duration) are necessary to achieve a 95 percent probability of capturing at least one Silver Carp, whereas a minimum of 42 hoop net-nights would be required to achieve this same cumulative detection probability for Bighead Carp. Even higher sampling efforts are likely necessary to achieve these same levels of confidence at sites with lower Asian carp abundance.

Unconventional Gear Development Project – The goal of this part of the project is to develop an effective trap or netting method capable of capturing low densities of Asian carp in the deep-draft canal and river habitats of the CAWS, lower Des Plaines River, upper Illinois River, and possible Great Lakes spawning rivers.

- Large (2 m) hoop nets captured fewer fish of all taxa, and fewer Asian carp than standard (1.2 m diameter) hoop nets.
- Surface-to-bottom gill nets captured more Asian carp than traditional gill nets during 4-hour sets.
- Driving fish into surface-to-bottom gill nets with pulsed-DC electrofishing gear captured more Asian carp than drives using traditional pounding methods or control sets.
- No Asian carp were captured in pound nets at Lake Calumet in 2013. Pound nets were effective at capturing large numbers of fish, including a high proportion of Asian carp, at Materials Service Pit (Marseilles pool) and at Lilly Lake (LaGrange pool).

FY 2015-2016 Actions:

- Contracting with a net builder we will re-design/tweak 2-m hoop nets to optimize catch rates.
- Applying pound nets in new locations and deploy in novel ways to increase catches where carp are present, as well as implement mobile electric barrier when available for trial and assessment.
- Evaluating pound nets designed for new areas.
- Maintaining novel gears.
- Testing USFWS novel gears (Mamou and Paupier nets) in the IWW. Compare efficacy with other experimental gears.
- Evaluating hydroacoustic data to compare efficacy of catch vs standing stock.

35. Use of Improved Gear and Novel Designs at Brandon Road

Expected Milestones:

- Demonstrate additional gears to use in upper IWW where fish are rare.
- Demonstrate additional gears to use in lower IWW where fish abundance is high.
- Construct total list of gears, specifications, and sources to share with partner agencies.

Outcomes/Output:

- Develop new gears and fine-tune existing ones to maximize detection and removal of Asian carp.
- Develop additional tools for detecting, stopping, and eliminating Asian carp from the waterway and elsewhere.
- Utilize additional tools wherever Asian carp exist to increase likelihood of capture.
- Develop additional tools for rapid responses, which can be deployed to maximize chances of capturing rare fish in deep channels or Great Lakes habitats.
- Develop additional tools to fish habitats that are hard to sample with more conventional gears.
- Develop tools that will be able to fish water more effectively and cost effective while minimizing mortality to native species.

Potential Hurdles:

- Cost of applying new technology may not have cost savings over existing methods.
- New technologies may not improve upon sampling efficiencies when actually deployed.
- New gears may be more expensive and require additional equipment to deploy as compared to traditional fisheries gear.
- Gears may catch fish where they are abundant, but may not increase ability to catch fish significantly where they are very rare.

36. Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System

Lead Agency: IL DNR

Agency Collaboration: Loyola University Chicago; USACE

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$24,000	$0

Project Explanation: Invasive species are a major threat to freshwater ecosystems across North America. An important step to reducing the impacts of these species, once they are established, is to prevent their spread to new waterbodies. The CAWS links the Mississippi River to the Great Lakes Basin and has become a focus for efforts to prevent the spread of non-native species. Much of the recent attention focused on the CAWS involves the potential for Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*H. molitrix*) to spread from the Mississippi River Basin into the Great Lakes. Many other species, however, pose a risk of increasing their range, and their total impacts, by migrating through the CAWS.

Apocorophium lacustre is an amphipod that has become established in large sections of the Mississippi River Basin. It is native to the Atlantic coast of the U.S., from the Bay of Fundy (Canada) in the north as far south as Florida. It has spread into the Gulf of Mexico, where it is considered non-native, and more recently into the Mississippi (1987-88), Ohio (2005), and Illinois Rivers (2003; years given are first records in the USGS NAS database). Records from the Illinois River in 2003 and 2005 indicate that the species was rapidly spreading upstream during the intervening years. Since 2005, however, there has been no coordinated attempt to monitor the spread of the species.

A. lacustre poses a large risk of spreading from the Illinois River, through the CAWS, and into Lake Michigan. Although its potential impacts have not been well studied, it may out-compete other benthic filter feeders, such as native mussels. In other regions where the species is established, these impacts have spread throughout foodwebs. These risks of dispersal and impacts resulted in this species being listed as a *Non-native Species of Concern and Dispersal Risk* by the GLMRIS.

This project is authorized under the GLMRIS. GLMRIS was authorized by Section 3061(d) of the WRDA of 2007 (WRDA 2007), Public Law 110-114. Specifically, the statute authorizes the Secretary of the Army (Secretary), acting through the Chief of Engineers, to conduct a feasibility study of the range of options and technologies available to prevent aquatic nuisance species from spreading between the Great Lakes and the Mississippi River basins.

Summary of Actions to Date: The most recent sampling of *A. lacustre* in the Illinois River is described as '*just upstream of the Dresden Pool*'. This sample was collected in 2005 and is the furthest upstream that the species has yet been recorded.

36. Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System

FY 2015-2016 Actions:

The objective of the proposed work is to determine the current distribution of *A. lacustre* within the upper Illinois River (Dresden Pool and areas upstream), CAWS, and nearby areas of Lake Michigan. This will enable a determination of how far the species has spread in the decade since it was last searched for in this region, its current proximity to Lake Michigan, and an updated assessment of the risk that it will spread into the Great Lakes.

Expected Milestones:

June 2015 Initiating project.
July-August 2015 All sampling takes place. Begin data entry.
August 2015 Lab identification of organisms and data entry.
Preliminary reports to IL DNR.
Final report to IL DNR made available to USACE and ACRCC.

Outcomes:

- Description of the current distribution of *A. lacustre* in the Illinois River (upstream of the Dresden Pool), the CAWS, and nearshore areas of Lake Michigan.
- This will allow an assessment of if and how the species has changed its distribution over the last decade.
- The major benefit of the work will be increased information about this potentially very harmful Great Lakes invader.
- Currently there is insufficient information available to determine what type of management is appropriate, and where it should be implemented.
- *A. lacustre* has been identified as a high-risk invader by the GLMRIS study but until its current distribution is known it will not be possible to implement wise management.

Potential Hurdles:

- Ability to detect *A. lacustre* with currently planned amount of effort.
- Weather, dangerous river/lake conditions could impede sampling.
- Loss of sampling devices due to navigation traffic, river conditions, or vandalism could prohibit data collection.
- *A. lacustre* could be detected in Lake Michigan.
- Additional sampling is needed to get appropriate resolution on presence/absence.

37. Community Initiatives to Increase Awareness, Surveillance and Enforcement

Lead Agency: IL DNR

Agency Collaboration: USFWS, state and federal law enforcement agencies, DFO/Canadian enforcement as necessary, INHS-IL/IN Sea Grant

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$300,000	$0

Project Explanation: While both Bighead and Silver Carp are listed under the Lacey Act as illegal to transport live, many local communities and/or markets continue to buy and sell live Asian carp for consumption and/or release into the wild according to ethnic customs or traditions. IL DNR proposes to increase officer presence and friendly enforcement activities related to Asian carp in a manner similar to the bait shop visits (Action Item 2.7.1). This has proved successful in promoting open dialogue between store owners, the public, and enforcement officials. Community involvement would focus on fish processors, markets, and other retail food establishments where live Asian carp are (or were) present. These activities will focus on markets known for having a preference for live fish for release or food preparation.

IL DNR staff and Conservation Police Officers will perform education and outreach activities, as well as on-site enforcement if necessary through informal site visits at fish processors, fish markets, and retail food establishments. In addition, import and export audits and inspections will be performed to ensure compliance with both the federal Lacey Act and Illinois Injurious Species Rule. CPOs will also be tasked with ensuring adherence to other laws and regulations by commercial fisherman. Interpretive materials will be developed for distribution to increase awareness of enforcement and additional outreach materials will be important for non-English speaking business owners and consumers. Because unintentional contamination has been suspected in other ANS, fish transportation and importation for food or stocking will also be investigated. Increased officer presence, education, and communication will enhance our understanding of this.

Summary of Actions to Date:

Law Enforcement

- At least four investigations of live fish in markets per year, regionally.
- Coordinated outreach and education for best management practices and regulations.
- Development of techniques to share information across language/cultural barriers.
- Increased surveillance of live fish haulers to prevent spread of ANS and specifically live Asian carp.
- Development of recommendations for policy or regulatory changes to address any identified gaps in control or management of Asian carp and of other ANS.

37. Community Initiatives to Increase Awareness, Surveillance and Enforcement

- Discussions with City of Chicago-Department of the Environment to coordinate regulations.
- Coordination with CPOs to coordinate enforcement efforts in Chicago-area restaurants and market places.
- Coordination with live fish haulers moving through Illinois.
- Investigations of live fish in regional markets.
- Coordinated outreach and education for best management practices and regulations.
- Interactions with local business to develop techniques to share across language/cultural barriers.
- Increased surveillance of live fish haulers.
- Evaluation of live Grass Carp sales in Chicago area and clarified rules that now will only permit live triploid grass carp to be sold as food (fish are dispatched upon sale).
- Educational materials produced to facilitate training in invasive species enforcement.
- Active participation and leadership role in Asian Carp Task Force.
- Arrest of aquatic life dealers illegally stocking and selling invasive species in Illinois.
- Plea agreements pending in court totaling over $24,000 in fines for aquatic life code violations.
- Bait dealer arrest for VHS, restricted species permits, and aquatic life dealer's license violations.
- Seizure and disposal of two shipments of illegal aquatic life.
- Discovery of illegal sale of aquatic life parts in fish markets.

Urban Fishing Pond Surveys

- Since 2011, 32 Bighead Carp have been removed from five Chicago area ponds using electrofishing and trammel/gill nets.
- Sampled four ponds with electrofishing and trammel/gill nets during 2013.
- Estimated 165 person-hours were spent sampling Chicago area ponds in 2013.
- Sampled 179 fish representing 5 species and 1 hybrid group.
- Six Bighead Carp were removed from Humboldt Park and Flatfoot Lake; a replica of the carp from Flatfoot Lake has been made for outreach and educational events.

FY 2015-2016 Actions: In 2014 and subsequent years, IL DNR will continue with the efforts started in 2012 working throughout the greater Chicago Area and expand the program to statewide site visits and surveillance, working with multijurisdictional teams when appropriate. Additional areas where live Asian carp may be moving within the state intentionally or unintentionally will be identified.

To expand these efforts, IL DNR will coordinate efforts with the USFWS along with local and regional jurisdictions.

37. Community Initiatives to Increase Awareness, Surveillance and Enforcement

Expected Milestones:

- Develop outreach and interpretive materials for businesses and consumers for awareness.
- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Establish consistent enforcement and understanding in Illinois, and train personnel in surrounding states using consistent enforcement techniques.
- Increase coordination with City of Chicago, and USFWS in these issues.

Outcomes/Output:

- Develop outreach and interpretive materials for businesses and consumers for awareness.
- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Increase coordination with multijurisdictional and regional fish hauling and movement of fish.
- Increase awareness and education by December 2012, and then build upon in 2013 to ensure compliance.
- Decrease or eliminate any illicit transportation of Asian carp within or across Illinois.
- Educate law enforcement that is not regularly involved with resource conservation in the Asian carp issues and further increase ability to stop illicit ANS movement and enforce regulations.

Potential Hurdles:

- Difficult to inspect non-registered locations, or black market dealers.
- Activity in other states/jurisdictions may affect Illinois commerce and activity.

38. Killbuck Creek Pathway Closure

Lead Agency: Ohio DNR

Agencies Collaboration: Ohio DNR Division of Engineering, Natural Resources Conservation Service (NRCS), Medina County Soil and Water Conservation District (Medina SWCD)

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$0	$0

Project Explanation: Closure of the AIS pathway at Little Killbuck Creek (LKC)

Summary of Actions to Date: The Great Lakes and Mississippi River watershed divide was assessed under the USACE GLMRIS to determine if there were viable pathways for the transfer of AIS. The GLMRIS Aquatic Pathway Assessment Report developed by the USACE for the LKC connection determined the risk for the transfer of AIS between both the Mississippi River and the Great Lakes basins. For the movement of AIS between the Mississippi River Basin and the Great Lakes Basin, this connection was rated a medium risk for the transfer of Silver Carp, Bighead Carp, Black Carp, Inland Silverside, and Northern Snakehead and a low risk for the transfer of Skipjack Herring. For the movement of AIS between the Great Lakes Basin and the Mississippi River Basin, this connection was rated a medium risk for the transfer of three spine stickleback, ruffe, tubenose goby, parasitic copepod, and viral hemorrhagic septicemia and a low risk for the transfer of European fingernail clam and European stream valvata.

The Ohio DNR DOW has facilitated numerous meetings with the Medina SWCD, NRCS, and the main landowner. The following is the timeline:

- November 19, 2012: Ohio DNR met with the Medina SWCD and the local NRCS representative to discuss the LKC GLMRIS study.
- September 19, 2013: Ohio DNR, Medina SWCD, and NRCS met with the primary landowner (Dewey Hall) to discuss the LKC GLMRIS study and the alternatives for closure (Other land uses, non-structural alternatives, and structural alternatives).
- November 25, 2013: Ohio DNR met with the Medina SWCD, the local NRCS representative, and representatives from the NRCS central office staff. A decision was made to have NRCS provide design assistance for structural alternatives.
- February 14, 2014: NRCS developed preliminary alternatives for structural closure. These alternatives will be discussed on March 17th. The two alternatives are to improve the current dike system or construction of a new dike along the historical watershed boundary.
- February 24, 2014: As part of the Governors State-of-the-State speech in Medina County, Ohio, the Ohio DNR Director met with the primary landowner and media to discuss the project.
- March 17, 2014: Ohio DNR met with Medina SWCD and NRCS to discuss the NRCS alternatives.

- April 24, 2014: ODNR, Medina SWCD, and NRCS met with the primary landowner to discuss the closure alternatives. We discussed the preferred alternative, how this alternative will impact his farming operation, and mitigation that can be implemented to ensure continued operation. The primary land owner is open to further discussion of the closure options and it was decided that Ohio DNR would conduct a preliminary analysis of the options and mitigation for impacts to farming operations.
- October 1, 2014: A consultant was selected to conduct a preliminary investigation of closure options at LKC. This study will be used to narrow down the closure options so that a final engineering study can be completed.

FY2015 Actions: A consultant will develop a preliminary assessment of the closure options by April 30, 2014. Ohio DNR DOW will then meet with the primary landowner and other potentially affected interests to evaluate and determine the preferred alternative for closure. This alternative will be based on cost and potential impacts to local landowners. No funds are anticipated for this part of the project.

FY2016 Actions: Ohio DNR DOW will contract with a consultant to develop final design plans for closure, including mitigation of impacts to the local landowners (for example, loss of production, changes to irrigation). Ohio DNR DOW anticipates having final plans developed by September 30, 2016. Ohio DNR DOW will work on permitting for the project during this time period.

Expected Milestones:

April 30, 2015	Consultant completes preliminary assessment of the closure options:
September 30, 2016	Ohio DNR DOW will select a final closure alternative and final closure design, and complete permitting.

Outcomes/Outputs:

- Closure of the LKC connection to impede the movement of AIS between the basins.

Potential Hurdles:

- The ability to develop a separation option that prevents the movement of AIS across the basin divide while allowing for landowner-desired continued agriculture operation and provides for minimization of flooding to surrounding properties.

39. Ohio Erie Canal Pathway Closure

Lead Agency: FY2015: USACE
FY2016: Ohio DNR

Agency Collaboration: Ohio DNR Division of Engineering and Ohio DNR Division of Parks and Recreation.

Funding Table

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$400,000	$0

Project Explanation: Closure of the AIS pathway at the Ohio Erie Canal (OEC)

Summary of Actions to Date: The Great Lakes and Mississippi River watershed divide was assessed under the USACE GLMRIS to determine if there were viable pathways for the transfer of AIS. The GLMRIS Aquatic Pathway Assessment Report, developed for the OEC connection, determined the risk for the transfer of AIS from the Mississippi River Basin to the Great Lakes Basin as a medium risk for the transfer of Silver Carp, Bighead Carp, Black Carp, and Northern Snakehead, and a low risk for Skipjack Herring.

- The Ohio DNR Division of Wildlife (DOW) met with the City of Akron to discuss the Aquatic Pathway Assessment Report. The Ohio DNR DOW and the USACE discussed the two primary areas of concern:
  - The direct transfer of water from the Mississippi River Basin to the Great Lakes Basin at the feeder gates that transfer water from Long Lake to the OEC.
  - Flooding at the tow path that allows water to move from the Mississippi River Basin to the Great Lakes Basin.
- The Ohio DNR DOW has met with USACE on numerous occasions to discuss closure options and determine a path forward.
- The Ohio DNR DOW facilitated Framework funding for the USACE to conduct a preliminary assessment of closure options at OEC.
- USACE completed the preliminary closure assessment in September 2014 with an array of potential options presented in the "Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures" (September 30, 2014). The array of options for closure was presented to the Ohio DNR DOW on September 29, 2014.

FY2015 Actions: Ohio DNR DOW will provide comments and direction on USACE's "Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures." With the FY 2015 GLRI funding that USACE received, USACE will complete the assessment of closure options with 100% design plans and finalized cost.

FY 2016 Actions: Once the final engineering design is complete, the Ohio DNR will facilitate a meeting with the Potentially Affected Interests (PAIs) to present the connection closure alternative(s) and the preferred path forward for closing the connection. Once there is consent

with respect to a path forward, the Ohio DNR DOW will work on project permitting. The Ohio DNR DOW will be the lead agency for the FY2016 permitting work.

Expected Milestones:

September 30, 2015 USACE completion of 100% design plans for closure alternatives.
September 30, 2016 Ohio DNR/USACE to present options to PAIs including the preferred alternative and complete permitting for the closure.

Outcomes/Outputs:

- Closure of the OEC to the movement of AIS between the basins.

Potential Hurdles:

- The ability to develop a separation option that prevents the movement of AIS across the basin divide that is acceptable the PAIs. Since this project area is part of the historic Ohio-Erie Canal, impacts will have to be mitigated through the State Historic Preservation Office.

40. Manage Waterway Traffic in Support of Asian Carp Control

Lead Agency: USCG

Agency Collaboration: USACE, IL DNR

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$1,600	$0	$0

Project Explanation: The USCG manages federally navigable waterways through the establishment and enforcement of Regulated Navigation Areas (RNA), safety zones, and security zones. Many waterways in the Chicago Area are designated as federally navigable waterways, including the Illinois River, the Des Plaines River, the CSSC, branches of the Chicago River, and the Calumet-Saganashkee Channel.

When operations associated with the electric fish barrier, rapid response actions, research projects, or any other Asian carp activity will impact the flow of traffic on a navigable waterway, the USCG issues an RNA or safety zone and provides notice to the public and mariners to inform them of the planned activities and expected impact on navigation. If a partial or full closure of a navigable waterway is required, the USCG may deploy assets on scene to enforce the closure. For extended closures, the USCG may also establish a temporary vessel traffic service that tracks delayed vessels and facilitates the orderly resumption of traffic after the closure is lifted.

To create an RNA or safety zone, the USCG must complete a rulemaking project, including public notice in the *Federal Register*. To streamline this process, the USCG created a safety zone in 2010 that covers 77 miles of the CAWS and allows the USCG to restrict or stop traffic for Asian carp activities. However, the USCG still strives to provide at least a 30-day notice to waterway users prior to a waterway closure.

Summary of Actions to Date:

- On May 1, 2010, the USCG put in place a Temporary Interim Rule (33 CFR 165.930) that established a 77-mile-long safety zone from Brandon Road Lock to Lake Michigan in Chicago, Illinois, including segments of the navigable waters of the Des Plaines River, the CSSC, branches of the Chicago River, and the Calumet-Saganashkee Channel. The purpose of the safety zone was to provide the Coast Guard Captain of the Port with the ability to take targeted and quick action to protect vessels and persons from the hazards associated with any federal and state efforts to control aquatic nuisance species.
- On December 2, 2010, the USCG put in place a Temporary Interim Rule that established an RNA (33 CFR 165.923) on the waters located adjacent to, and over, the electric fish barrier. The RNA prescribes requirements for vessels passing over the barrier to protect them from hazards associated with the barrier. This Temporary Interim Rule also established a safety zone that restricts vessels from transporting non-potable water across the barrier with the intention of discharging the water on the other side.

- On July 18, 2011, the USCG put in a place a Final Rule that established a permanent safety zone covering the same 77 miles of waterways covered by the Temporary Interim Rule issued in May, 2010 (33 CFR 165.930).
- On December 12, 2011, the USCG issued a Final Rule to make the safety zone and RNA, created under the Temporary Interim Rule issued in December 2010, permanent (33 CFR 165.923).
- On July 15, 2013, the USCG issued an Interim Rule amending the RNA (33 CFR 165.923) to restrict vessels 20 feet or less in length, and personal or human-powered watercraft of any kind, from crossing the electric fish barrier.
- On September 17, 2013 the USCG RDC delivered a report titled "Chicago Sanitary And Ship Canal (CSSC) Marine Safety Risk Assessment." This report categorized risks to mariners and shore personnel in the vicinity of the CSSC electrified barriers near Romeoville, Illinois.

FY 2015 Actions: The USCG will issue and enforce a series of full and partial waterway closures as necessary to support electric fish barrier maintenance, barrier construction, barrier testing, and any other ANS control activities that may affect the safety of vessels and mariners on federally navigable waterways throughout FY 2015. In addition, the USCG intends to adjust the safety zone and Regulated Navigation Area contained in 33 CFR 165.923 based on observations in the CSSC Marine Safety Risk Assessment.

FY 2016 Actions: The USCG will issue and enforce a series of full and partial waterway closures as necessary to support electric fish barrier maintenance, barrier construction, barrier testing, and any other ANS control activities that may affect the safety of vessels and mariners on federally navigable waterways throughout FY 2016. The USCG may also develop new safety zones or RNAs to support new aquatic nuisance species initiatives.

Expected Milestones:

- None. Activities are carried out on an as-needed basis.

Outcomes/Outputs:

- Appropriate control of vessel traffic to protect vessels and persons from the hazards associated with any federal and state efforts to control aquatic nuisance species.

Potential Hurdles:

- Waterway closure requests that are provided to the USCG less than 35 days prior to the event do not provide enough time for the USCG to provide appropriate public notice. Waterway restrictions and closures should be planned and coordinated between agencies whenever possible to facilitate the regulatory process and minimize the impact to waterway users.

41. Brandon Road Lock and Dam Risk Assessment

Lead Agency: USCG

Agency Collaboration: USACE, USGS, USFWS

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$2,000	$0	$0

Project Explanation: Various agencies are evaluating the use of aquatic nuisance species barriers at Brandon Road Lock and Dam to help prevent the movement of Asian carp toward the Great Lakes.

To ensure the safety of personnel and vessels transiting the lock, as well as personnel operating the lock, agencies must evaluate and address safety risks throughout the research, design, and construction process.

Summary of Actions to Date: The USCG has monitored ongoing research and design projects and emphasized how the risk profile at Brandon Road Lock differs from the risk profile at the existing electric fish barrier.

FY 2015 - 2016 Actions: The USCG will continue to monitor ANS control technologies being developed for use at Brandon Road Lock and Dam and help lead agencies identify and evaluate risks to personnel and vessels; help identify mitigation measures early in the design process; and observe and evaluate safety testing associated with ANS control measures.

Expected Milestones: See individual agency projects for milestones.

Outcomes/Outputs:

- Appropriate measures that promote navigation safety for commercial and recreational mariners transiting Brandon Road Lock.

Potential Hurdles: None.

42. Electric Barrier Construction and Operation Risk Assessment

Lead Agency: USCG

Agency Collaboration: USACE

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$2,000	$0	$0

Project Explanation: The USCG has put mitigation measures in place to address the simultaneous operation of the Demonstration Barrier at 1 Volt per inch (V/in) and Barriers IIA and IIB at 2.3 V/in based on past risk assessments. The USACE is currently building a permanent Barrier I in between the Demonstration Barrier and Barrier IIB.

To ensure the safety of personnel and vessels crossing the electric barrier system, a risk assessment will be completed to evaluate risks posed by the primary, alternative, and tertiary operating configurations after Barrier I is completed. This risk assessment should evaluate the appropriateness of the current risk mitigations measures for the new operating conditions and recommend any changes needed to (1) promote navigation safety for commercial and recreational mariners transiting the CSSC in the vicinity of the barrier; and (2) safe work practices and operating standards for commercial facilities that operate or moor vessels in the vicinity of the barrier.

Summary of Actions to Date: The Coast Guard Research and Development Center (RDC) conducted rescuer safety testing in the electrified barrier zone, participated (as observers) in the February 2011 USACE Barrier Safety Testing, and conducted peer-review of the report on the 2011 safety testing.

During July 2011, the RDC conducted and reported on additional rescuer safety testing independent of the follow-on USACE safety testing for Barriers IIA and IIB. In 2013, RDC conducted and reported on barrier field and vessel operation interactions at the barge loading facility just north of the barrier zone. In 2013, RDC also completed an all-encompassing Marine Safety Risk Assessment that addressed both shoreside and waterway activity at up to 3 miles upstream from the barrier zone.

FY 2015 Actions: Observe and evaluate USACE safety test planning as work on Barrier I continues. Determine whether Coast Guard requires additional testing or test revisions that address measures necessary to promote the safety of vessels, mariners, and facilities in the vicinity of the electric fish barrier.

FY 2016 Actions: Participate in/evaluate USACE safety testing finalization as work on Barrier I is completed. Based on proposed safety testing, investigate the degree that testing is sufficient to implement measures as necessary to promote the safety of vessels, mariners, and facilities in the vicinity of the electric fish barrier.

42. Electric Barrier Construction and Operation Risk Assessment

Expected Milestones: See the Barrier I construction project for milestones.

Outcomes/Outputs:

- Appropriate measures that (1) promote navigation safety for commercial and recreational mariners transiting the CSSC in the vicinity of the barrier; and, (2) safe work practices and operating standards for commercial facilities that operate or moor vessels in the vicinity of the barrier.

Potential Hurdles: None.

43. Program Support for Asian Carp Activities

Lead Agency: USFWS

Agency Collaboration: IN WF

Funding Table:

Funding Year	Agency Funding	Asian Carp GLRI Funding	Other Funding
FY 2015	$0	$100,000	$0

Project Explanation: Funding received under this project would allow the Service to continue to contractually engage the Asian Carp Team (through the Indiana Wildlife Federation) to perform duties, as directed by the Service, to support and facilitate ACRCC efforts to prevent invasive Asian carp from establishing in the Great Lakes. Currently, framework funds are being used to fund this work through September 10, 2015. Additional funds are needed to implement a second year of work through September 10, 2016, if desired and supported by the ACRCC.

Summary of FY 2014 Actions:
Contractual work began on September 10, 2014. Assigned tasks fit under four major categories:

1. Assist the Service with the logistics of its participation in and coordination of the ACRCC;
2. Assist the Service in its development of its annual report identified in the Water Resources Reform and Development Act of 2014 (WRRDA 2014);
3. Assist the Service in its efforts to ensure bi-national (United States and Canada) coordination in sharing Asian carp control effort information, including efforts under the national Asian carp control plan titled Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States, and dated November 2007, and the document prepared by the ACRCC titled 2014 Asian Carp Control Strategy Framework;
4. Assist the Service in its interagency and intergovernmental coordination efforts; and assist with the Service's communication and outreach activities as part of the ACRCC's development of the 2015 Asian Carp Control Strategy Framework.

FY 2015 Actions: Work in FY 2015 will continue per the contract scope of work approved by ACRCC Senior Executive members in October 2014.

FY 2016 Actions: If funded, work in FY 2016 would continue per the contract scope of work approved by ACRCC Senior Executive members in October 2014.

Expected Milestones:

- Assistance to effectively coordinate activities of the ACRCC.
- Assistance in developing the annual report to Congress per the WRRDA of 2014.

43. Program Support for Asian Carp Activities

- Effective assistance in coordinating information sharing regarding Asian carp control efforts under the Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States and the Asian Carp Control Strategy Framework.

Outcomes/Outputs:

- Continued effective function of the ACRCC.
- WRRDA Annual Report to Congress.

Potential Hurdles: None.

ACRCC

Appendix C

Acronyms

Appendix C

ACRCC	Asian Carp Regional Coordinating Committee
ACSC	Asian Carp Scientific Committee
AIS	Aquatic Invasive Species
ANS	Aquatic Nuisance Species
ANSTF	Aquatic Nuisance Species Task Force
Barrier	Electric Dispersal Barrier
BMP	Best Management Practice
CAWS	Chicago Area Waterway System
CEQ	Council on Environmental Quality
CO_2	Carbon Dioxide
CPO	Conservation Police Officer
CSSC	Chicago Sanitary and Ship Canal
CWG	Communications and Outreach Workgroup
DFO	Department of Fisheries and Oceans
DIDSON	Dual-frequency identification sonar
DNR	Department of Natural Resources
eDNA	Environmental deoxyribonucleic acid
ECALS	Environmental deoxyribonucleic acid calibration studies
EDRR	Early Detection and Rapid Response
EIS	Exotic Invasive Species
EOG	Electro-olfactogram
ERDC	USACE Engineering Research and Development Center
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FMN	Fish Monitoring Network
FWCO	Fish and Wildlife Conservation Office
FY	Fiscal Year
GIS	Geographic Information System
GLC	Great Lakes Commission
GLFC	Great Lakes Fishery Commission
GLMRIS	Great Lakes and Mississippi River Inter-Basin Study
GLNPO	Great Lakes National Program Office

GLRI	Great Lakes Restoration Initiative
GLWQA	Great Lakes Water Quality Agreement
GPS	Global Positioning System
GSI	Gonodosomatic Index
ICS	Incident Command System
IEPA	Illinois Environmental Protection Agency
IL DNR	Illinois Department of Natural Resources
ILNHS	Illinois Natural History Survey
IN DNR	Indiana Department of Natural Resources
IN WF	Indiana Wildlife Federation
IPM	Integrated Pest Management
ISU	Invasive Species Unit
IWW	Illinois Waterway
MICRA	Mississippi Interstate Cooperative Resource Association
MI DNR	Michigan Department of Natural Resources
MN DNR	Minnesota Department of Natural Resources
MRBP	Mississippi River Basin Panel
MRP	Monitoring Response Plan
MRWG	Monitoring Response Workgroup
MWRD	Metropolitan Water Reclamation District
NAS	Nonindigenous Aquatic Species
NEPA	National Environmental Policy Act
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
OFAH	Ontario Federation of Anglers and Hunters
OH DNR	Ohio Department of Natural Resources
OMNRF	Ontario Ministry of Natural Resources and Forestry
ORB	Ohio River Basin
ORFMT	Ohio River Fisheries Management Team
PCR	Polymerase chain reaction
QA/QC	Quality Assurance/Quality Control

Appendix C

QAPP	Quality Assurance Protection Plan
qPCR	Quantitative polymerase chain reaction
RAP	Research Affiliate Program
RM	River Mile
SIU	Southern Illinois University
SOP	Standard Operating Procedure
UMESC	Upper Midwest Environmental Sciences Center
UMRB	Upper Mississippi River Basin
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
US DOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VPS	Vemco Positioning System
WGL	Whitney Genetics Laboratory
WI DNR	Wisconsin Department of Natural Resources
WRDA	Water Resources Development Act of 2007
WRP	Wetland Reserve Program
WRRDA	Water Resources Reform and Development Act of 2014
YOY	Young-of-Year